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RECRUITMENT AND EFFICIENCY IN THE CIVIL SERVICE

THE Prime Minister, in a statement on the Civil Service on June 24 in the House of Commons, paid a well-deserved tribute to the Service as a whole. This praise was timely, for much current criticism of the Civil Service has been both unfounded and unfair, and has been directed against officials when it should rightly have been directed against those responsible for the policies which the Civil Service is called upon to execute. Mr. Attlee was right to repudiate the fashion of slighting the Civil Service, and to point out that we shall neither get the best out of the Service nor be able to recruit to it the energetic and able young men and women it needs if the practice of depreciating its work continues.

Much less satisfactory, however, was that part of the statement dealing with the future plans for reducing the size of the Civil Service. The Prime Minister gave four main reasons for not expecting large reductions at the present time. There is still much work to be done arising out of war conditions, such as work on war damage and re-settlement. While shortages compel the retention of rationing and other controls, a considerable staff is required for such work, amounting to 44,000 of the Civil servants employed on temporary work. Then, measures approved by the House, such as those dealing with the social services, education and civil aviation, cannot be implemented without such staff; and finally, there are the large staffs who, without substantially changing their duties, will shortly be transferred from outside the Civil Service to the Ministries of Agriculture and of National Insurance.

Up to a point, these are valid reasons; but they make it the more imperative that there should be a radical reconsideration of the systems of controls and of the internal organisation of the Civil Service from the point of view of the most efficient use of available man-power. Apart from the efficiency of a particular system of control, there may come a point when retention of the control does not justify the expenditure of man-power on its continuance. The same man-power expended on productive purposes might, even where an imported commodity is concerned, more than offset the drawback of increased import to supply a reasonable demand and prevent scarcity. If it is to be accepted, as the Prime Minister said, that the size of the Civil Service depends mainly on the jobs it is given to do, it is an over-riding imperative in the present man-power situation that the Government should see that these jobs are held in such constant review that all non-essentials are eliminated as conditions change. It is equally important in such a review that the effect on the national efficiency and economy as a whole should be kept in mind. The Prime Minister's statement referred to the 258,000 out of a total of 722,000 non-industrial Civil servants who are in the Post Office. The repeated criticism of the recent curtailment of postal services suggests that the cutting down of staff has been dictated more by near-sighted economy than by a broad view of the importance and implications

of an essential service. It is not too much to say that the restrictions have more than offset many of the improvements in speed of communication which applied science has brought, and given us in Britain to-day a postal service well below the standard of that of the nineties of last century.

Both these factors bear on the question of recruitment, to which the Prime Minister devoted the latter half of his statement. Unless a high standard of public service is maintained and administrative review continually eliminates redundant posts, the mere cessation of the attacks to which the Prime Minister referred will be of little avail. Recruits of the high standard required will neither be attracted to the Service nor remain with it unless they find in their work the satisfaction of genuine public service.

That was a point effectively made by Sir Oliver Franks in his lectures on "Central Planning and Control in War and Peace". The satisfaction of doing a job related in a direct and intelligible way to the national need should be an incentive which counts for more than a little in helping the Civil Service to recruit men and women of the type it needs. So far as recruitment to the Service is concerned, however, Sir Oliver did not discuss the aggregate size of the Service; he limited himself to insisting on the need for providing the Civil Service with more experts possessing both specialized training in the techniques of forecasting and estimating and knowledge of the world, and on the urgent need of relieving the chronic overwork of senior Civil servants, particularly those in departments dealing with economic affairs.

Sir Oliver made two suggestions here: first, the use of advisory groups of men drawn largely from industry and commerce, and secondly, the creation of additional posts of 'second secretary', free from departmental duties. From the point of view of organisation, it might well be argued that the latter suggestion does not go far enough, and that it would be sounder practice to separate the administrative and the planning or advisory responsibilities of the 'permanent secretaries' so that no one individual carries the responsibility for running a large department and for planning and advising the Minister on policy. The essence of both suggestions, however, is not merely to provide the senior Civil servant with that degree of leisure upon which sound judgment in planning depends, but still more the association with the Civil Service of men with a wider outlook, experience and training than at present.

This is one of the main points made in a recent broadsheet entitled "Recruiting Civil Servants" issued by Political and Economic Planning (No. 266. May 23, 1947). The main purpose of this broadsheet, which is a preliminary study prepared by the P.E.P. Manpower Group, is to examine the extent to which the principles and methods of recruitment and training affect the way in which jobs are done. It is pointed out that since the jobs entrusted to Civil servants are the result of policy decisions taken at the political level, it is only in the way they do the jobs given them that Civil servants can legitimately be criticized. The broadsheet considers in turn the main classes of the Home Civil Service and then the Foreign and Colonial Services, but the administrative class is discussed at greatest length.

Hitherto, the administrative class has probably been weakest on questions of organisation and management, as was indicated in the Sixteenth Report from the Select Committee on National Expenditure for the Session 1941–42; and the report of the Assheton Committee on the Training of Civil Servants has since formed the basis for a serious effort to give Civil servants a systematized professional training. A director of training and education was appointed at the Treasury in January 1945, with responsibility, in association with the joint Whitley Council on Training, for exercising general control and guidance over training policy throughout the Service and for conducting training courses where this can be done better centrally than in each department. All the larger departments have now organised schemes of training, giving particular attention to making proper arrangements for receiving the new entrant and helping him to understand the enormous organisation he has joined.

The administrative class needs, however, a wider variety of talent than it has had in the past. The kind of men likely to improve defects in the organisation of the Service are those who would make good business executives: men of good intelligence and with outstanding qualities of personality—imagination, drive and balanced judgment. The P.E.P. Broadsheet urges that a proportion of the new entrants should be chosen primarily on these grounds. It is intended to restore the normal competitions not later than 1949. The majority of the entrants will then be selected by the pre-war method; but a proportion will be taken from people with at least a good second-class honours degree, who will be judged on their previous careers, coupled with an interview and a few written tests of a general character. This is a major change in the principle and method of recruitment to the administrative class, and if it is to be successful it is vital that the right qualities should be sought and that they should be satisfactorily assessed. Methods normally used by interview boards, and consequently the decisions reached, are not entirely reliable; and the experience of the armed forces in selecting officers during the War showed that better results were obtained when the interview was supplemented by practical 'situation' tests, particularly group tests. Further experiment and some modification of the methods may be required; but the technique undoubtedly offers one of the most promising approaches yet devised for assessing personal qualities, and should be adopted for selecting candidates who are to be chosen mainly on personality.

For all these encouraging signs of change, there are two features which suggest that the recommendations of the Select Committee on National Expenditure five years ago have as yet had little effect. The establishment work of the Civil Service still appears to compare most unfavourably with that of the best large firms; the re-allocation of staff lags far behind changes in the volume of work, and the allocation of individual officers often takes little

account of particular qualities or of personal preferences. Such failings will not be rectified until establishment work is regarded as of the first importance and is therefore assigned to officers of the highest ability. Courses of training in modern methods of personnel and business management would be a useful supplement, and in this field at least the suggested Administrative Staff College might well make a valuable contribution towards increasing the efficiency of the Civil Service.

On the professional, scientific and technical classes of the Civil Service, Political and Economic Planning in this broadsheet merely observes that the method of selection, designed primarily to assess a candidate's professional ability, seems to be adequate, and that conditions of service and salaries for scientific workers are now attracting many men and women who might otherwise have taken up academic appointments. So, too, of the Colonial Service, the broadsheet sees no reason to doubt that the courses of training, comprehensive and imaginative in scope, which have been entrusted to the universities, will be well conducted; and suggests that the Foreign Service should devote equal care to planning the training of new recruits, including suitable courses at universities in Great Britain and abroad. In particular, the six months training which it is already proposed should be spent in the study of economic, industrial and social questions will require very careful planning. It will not be enough for officers merely to tour Government departments and industrial concerns. Such visits should be the practical complement of an academic course.

The two final conclusions of this broadsheet bring us right back to the Prime Minister's statement. First, there is the warning against sacrificing training schemes to a desire to cut staff. Training makes for a more efficient staff, and an efficient staff can do the same amount of work with fewer workers than an inefficient one. Whatever decisions of policy the Government may take which affect the amount of work required of the Civil Service, the man-power of the country as a whole demands that the most efficient use shall be made of everyone who enters the Civil Service at whatever level, and that no one shall be retained who is unsuitable for his or her work or engaged in duties that are no longer indispensable.

For the same reason, the second conclusion is vital. Methods of recruitment and training should be reviewed from time to time in order that they may be adapted to changes in the national system of education and in the functions of the Civil Service. That, however, is only a small part of that long-neglected recommendation of the Tomlin Commission concerning surveys forming part of a systematic and periodic overhaul of the machinery of Government, to which the Select Committee directed attention. There is no suggestion in the Prime Minister's recent statement that any importance is attached to such efficiency audits at any level, and yet they are at least as essential as when the Select Committee reported in 1942.

It is idle for the Government to call so loudly for increased efficiency in production unless it insists on its own departments, such as the Post Office, making serious efforts to relate the loss of productive efficiency in the country caused by delays in essential services with the man-power savings in the staff reductions that have been made. It may be that all the possibilities of re-organisation and other factors in the General Post Office have been considered and correctly weighed; but the public is entitled to be told, and all the more for the overwhelming amount of goodwill towards this department which was manifest in the recent debate. The existence of such goodwill is one vital factor in obtaining the right kind of staff in any part of the Civil Service, and in maintaining its keenness and efficiency when recruited. No amount of care expended on recruitment or training can compensate for mistakes in policy and administration by the Government itself, which dissipate public goodwill and also the incentive inside the Service coming from the satisfaction of a visible public need and its generous appreciation.

BIOCHEMISTRY OF CANCER

Biochemistry of Cancer

By Jesse P. Greenstein. Pp. viii+389. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.80 dollars.

THE deficiency in books on laboratory cancer research is particularly unfortunate since so many new workers are turning their attention to the problems of malignant disease. The present volume is therefore assured of a wide welcome, representing as it does a valuable, indeed indispensable, addition to the cancer literature. The fact that this book follows so soon after K. Stern and R. Willheim's "The Biochemistry of Malignant Tissues", which was published in New York in 1943, illustrates the great attention now being given to biochemistry in relation to cancer in the United States, where it is widely felt that the more dynamic approach to the problems of normal and malignant growth which biochemistry supplies should be fully developed to supplement and reinforce the well-tried methods of classical histology.

It is instructive to compare these two recent books, both of which are good of their kind though entirely different in content and in mode of thought. Stern and Willheim set out to write a conventionally planned systematic work of reference, classified under tissue components and seeking completeness, and therefore largely uncritical in the selection of data. Dr. Greenstein, on the other hand, has exercised much discrimination in what he includes, and the whole book is strongly flavoured with a vigorous and critical personality and a decidedly individual outlook. His choice of material will not please everyone, and the emphasis which he puts on very recent work (the book is fully up to date) sometimes leads to the exclusion of older and more basic investigations and may thus give some readers an unbalanced view of the subject. For this reason a combination of the study of these two books has much to recommend it. Dr. Greenstein's numerous tabulations of a wide variety of numerical data are particularly useful, and his method of approach undoubtedly possesses the great advantage of avoiding that tedious chronicle of confirmatory, and alas of contradictory, observations which are characteristic of most books on

cancer. In this subject the temptation to jump ahead of the available data is only to be resisted by the strongest self-control, and in this respect the modern worker ought to be in a much better position than his predecessors, many of whom were obliged to restrict their experiments to a few mice. One of the great merits of the National Cancer Institute at Bethesda, of which Dr. Greenstein is head biochemist, is that it possesses facilities and staff covering the whole range of scientific activities needed for cancer research. How great a contribution this large-scale organisation of research has made to the biochemistry of cancer is made abundantly clear in this book, though the author is under no illusion that new discovery, as distinct from the application of known principles, can ever be mass-produced (see p. 375).

After a brief introductory chapter on the origin, transmissibility, and general nature of cancer, the three main sections deal with induction of tumours (108 pp.), controlling factors (34 pp.), and properties (200 pp.). In the first of these, the extrinsic factors, including the known chemical and physical carcinogens, are described; a rather brief account of the pioneer investigations of E. L. Kennaway, J. W. Cook, and their colleagues at the Cancer Hospital being followed by a somewhat more detailed description of the subsequent American work. This is succeeded by a useful section on the metabolism of the carcinogens in the animal body, a matter which may help to explain the differences in carcinogenic power found in different species. The reviewer may perhaps mention that the explanation suggested for the loss of carcinogenic power of benzpyrene when dissolved in solvents containing phospholipins (see p. 63) does not hold for experiments in which the amount of benzpyrene actually injected was determined by analysis (F. Dickens and H. Weil Malherbe, *Cancer Research*, **2**, 560 (1942); **4**, 425 (1944); **6**, 161, 171 (1946)).

Under the heading "Intrinsic Factors" is a useful account of the influence of sex-hormones and of the mammary tumour inciter, the milk-borne factor discovered by J. J. Bittner in 1939, which renders certain strains of mice liable to breast cancer when they become older. Although no evidence yet indicates that this observation applies to other species, probably most cancer workers would attribute to it higher importance than Dr. Greenstein gives it here, if only because of its remarkable theoretical significance. The same applies to the interesting observation, now fully confirmed, that cancer can be induced in mice by suitable extracts of human tissues. Although the activity of such extracts is rather feeble, and it is not yet proved that the carcinogenic properties do not arise through alteration of the extracted substances during the manipulations, it seems to be going too far to suggest (p. 134) "that the results merely demonstrate the relative susceptibility of mice to carcinogenic agents of most any and all sorts (*vide infra*)". One has the impression that much of this book was hastily written, for example, the frequent use of *vide infra* for references to earlier pages, the occurrence of uncorrected printing errors, and the occasionally confusing English, as on p. 260, where the account of the cytochrome system is difficult to follow. This is a pity, for the excellent material deserves a more careful presentation.

The final chapters on the properties of tumours contain the most comprehensive account of the enzymic distribution in cancer tissue which has yet been written, and coming from one who has himself made valuable contributions to this subject, this authoritative section would alone have justified the publication of the book. As in the other chapters, full bibliographies are included, and there are author and subject indexes. The general conclusion is that the cancer cell is working with most of its enzymic machinery fully extended to meet the demands upon it, and has therefore less reserves of metabolic catalysts available than the normal cell possesses. This is an important generalization, and, if it stands up to further critical experiments, may perhaps form the basis of a future scientific therapy of cancer.

F. DICKENS

DIET AND VITAMINS

The Nation's Food

A Survey of Scientific Data. Edited for the Society of Chemical Industry (Food Group) by A. L. Bacharach and Theodore Rendle. Pp. xvii+349. (London: Society of Chemical Industry, 1946.) 18*s*. net.

Vitamins and Hormones

Advances in Research and Applications. Edited by Prof. Robert S. Harris and Assoc. Prof. Kenneth V. Thimann. Vol. 4. Pp. xvii+406. (New York: Academic Press, Inc., 1946.) 6.80 dollars.

HERE are two volumes which no serious worker on nutrition can be without. In "The Nation's Food" will be found an authoritative summary of almost all that is at present known about the nutritive value, and the chemical and even physical properties, of British foods. The first section of the book deals with the egg as food, the second with the potato as food, the third with vegetables as food; and parts four, five, six and seven, respectively, with cereals, meat, fish and milk, all treated "as foods". Thus no important article of diet is omitted. Each of these seven sections is further subdivided, in a methodical manner, into a series of chapters, dealing in turn with such aspects as the biology of the food in question, its chemistry, nutritive value, production, effect of cooking, storage, and so on. These chapters—twenty-seven in all—are contributed by the leading experts in each field; and thus the book is bound to be useful both to the specialist, who will need it for reference and for study, and also to those whose interests are more general, including, no doubt, caterers, dietitians and food manufacturers.

The Food Group (and its Nutrition Panel), a constituent section of the Society of Chemical Industry, under whose auspices the papers published in this book were originally delivered as a series of lectures, are deserving of our warmest thanks. So also, assuredly, are the authors and the editors, who have gone to so much trouble in their work of extending, revising and editing their manuscripts since these lectures were first given, in order that we may now have their expert knowledge before us for our more permanent use.

"Vitamins and Hormones" is likewise an authoritative compilation by a number of experts; and volume IV, the latest to appear, will be as welcome as were the earlier numbers, and will be needed by all those departmental libraries which specialize in these branches of science. The plan here is somewhat different from that of the book first reviewed, for in "Vitamins and Hormones" contributions are published not in any logical sequence but in the necessarily more fortuitous order in which they

could be commissioned and delivered. Thus volume IV is made up of the following contributions in order: "The Newer Hematopoietic Factors of the Vitamin B-Complex", by J. J. Pfiffner and Albert G. Hogan; "Nutrition and Resistance to Infection: the Strategic Situation", by Howard A. Schneider; "Manifestations of Nutritional Deficiency in Infants", by F. W. Clements; "Effect of B Vitamins on the Endocrinological Aspects of Reproduction", by Roy Hertz; "Nutritional Therapy of Endocrine Disturbances", by Morton S. Biskind; "The Thyroid and Diabetes", by Bernardo A. Houssay; "Thyroactive Iodinated Proteins", by E. P. Reineke; "The Protein Anabolic Effects of Steroid Hormones", by Charles D. Kochakian; "Methods of Bioassay of Animal Hormones", by Sidney A. Thayer.

The style and standard of the contributions vary considerably: some of them are relatively exhaustive in scope, some less so; some are in the form of critical appraisals of the present outlook, whereas others are more in the nature of a collection of abstracts. A useful feature is the system of headings, sub-headings, and sub-sub-headings, which appear both in the table of contents, and in the actual review article itself. This makes for ease in consultation. For example, in the review on "Methods of Bioassay of Animal Hormones", by Sidney A. Thayer, "Section IX" of the review is concerned with "Bioassay of Adrenal Cortical Hormones", "Section IX: 2" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats", "Section IX: 2, a" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats, Experimental", and "Section IX: 2, a-γ" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats, Experimental—Final Assay Procedure".

Not very many workers on vitamins are active in the field of hormones, or *vice versa*, and some readers may have questioned the practical advantage of joining the two subjects together in the one periodical. In their preface to the present volume, the Editors take up this very point. They refer to the "increasing interrelationship between vitamin and hormone research", which as they say is "exemplified in three articles in the present review". They therefore conclude that this "justifies the Editors' initial feeling that the bringing of reviews of these two fields under one cover would prove realistic and helpful".

LESLIE J. HARRIS

GEOLOGICAL GUIDE-BOOK OF OXFORD

The Geology of Oxford

By Dr. W. J. Arkell. Pp. viii+268+6 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 20*s*. net.

NEARLY eighty years ago there issued from the Clarendon Press Phillips' "Geology of Oxford and the Valley of the Thames", a classic among geological guide-books. Here, from the same Press, with a shortened title and reduced bulk, appears another. Stratigraphers who possess, and perpetually consult, Dr. Arkell's "Jurassic System" will not need to be assured that "The Geology of Oxford" is an erudite, documented and yet readable book. Although the area dealt with in detail is comprised within a ring of some thirty miles radius around Oxford, comments and comparisons range over Europe and beyond, so that the book provides a sketch of Mesozoic and later stratigraphy in which one small portion is elaborated. It is essentially a book for students, but for students everywhere.

A concise first chapter introduces the Palæozoic platform on and about which the main subject-matter is to accumulate. The contrast between "Palæo-Europe" (on which Oxford stands) and "Meso-Europe" (which is attached to it along the south side of the Mendip–Ardennes line) explains the diversity of the post-Triassic sedimentary history of the area.

The remaining seventeen chapters treat of the deposition, classification, deformation and disposition of the rocks of the successive periods. It is refreshing to find in their headings the good old English names that nowadays are so often lost in the intricacies of zonal nomenclature. There is nothing old-fashioned in the chapters themselves. Each starts with an uncompromising list of the zones, followed by a summary of the local and regional characteristics of each. Then come the local details; there can be few exposures within the chosen area that are not analysed with meticulous care. It is a testimony to the author's style that even these purely descriptive paragraphs, lists of fossils and all, make interesting reading.

The first ten chapters constitute an amplification, with slight revision, of the corresponding parts of the author's "Jurassic System". Such modifications in classification as appear in this newer account result, on the whole, in simplification. In the chapters dealing with the Cretaceous and Tertiary systems there seems to be an increased reliance on the work of others; these chapters are summaries of diverse opinions rather than expressions of personal conviction. This in no way lessens their value to the student, nor does it exclude ingenious and provocative comments. The author seems to accept, with but little reservation, the latest heresies in respect of the Chalk, its origin and its flints. That the Chalk Sea was relatively shallow is as sound a deduction as that it was extremely wide; but it is hard to believe that an area of water covering most of Europe could have permitted desert conditions to prevail over the surviving patches of land. Coastal sand-dunes do not necessarily imply a Saharan hinterland. Again, the author is content to postpone the segregation of silica into flints until the Montian stage (with a second gathering in the late Miocene period). While it must be admitted that much flint has 'grown' in the Chalk since Cretaceous times (it may, indeed, be forming still), some of it must surely be contemporaneous. The unshrivelled form of the ectosarc of sponges, or the ampullae of Echinoids, to mention but two common occurrences in 'flint-fossils', must have received their 'petrifying' coating within a few hours of death.

The chapters on the Pleistocene recover the personal touch and provide much valuable information and correlation of local developments. Many of the interpretations may be debatable; but that is normal for the period.

The index is a model of its kind and ensures the value of the book as a work of reference. The text-figures are adequate and clear, the author's drawings of fossils being particularly good. The plates are perhaps less satisfactory, but they are few. It is

strange to find as the frontispiece to a work on Oxford a touched-up aerial view of White Horse Hill, the 'Mecca' of the men of Berkshire. But it will be realized that if criticism is reduced to such trivial points, the real reaction to this book is one of unstinted welcome; every serious student of stratigraphy, whether he works near Oxford or not, will find its facts indispensable and its arguments stimulating.

H. L. HAWKINS

STRUCTURE OF SPECTRAL LINES

High Resolution Spectroscopy

By Dr. S. Tolansky. Pp. xi+292+4 plates. (London: Methuen and Co., Ltd., 1947.) 21*s*. net.

THE author of this book has given an account of the experimental techniques used in the investigation of the structure of spectral lines; but he has not stated in the introduction whether it is intended to be primarily a historical account or to be a text-book giving a critical description of methods now in use, and the book suffers from a confusion of these points of view. On one hand, there is lacking an account of the work which has been done in the past with the methods described, and on the other hand, obsolete instruments are described in too much detail; and avoidable inaccuracies seriously reduce the value of the book from both of these points of view. In spite of the length of the book, important experimental details have been omitted, too much space having been devoted to academic theoretical considerations.

The first five chapters contain a detailed account of the light sources used for obtaining narrow spectral lines; but a summarized comparison of the advantages and limitations of the different methods is not given. The description of the hollow cathode tube is concerned too much with complicated and obsolete forms of this light source. In the account of the atomic beam the advantages of the method of observation in absorption have not been fully appreciated. For example, it is stated on p. 82, "it is therefore very easy to miss weak components . . .", while in fact it is one of the merits of this method (as of all absorption methods) that it is specially suited to the observation of weak components (the weak components in the potassium resonance lines, due to the rare isotope K41, have been found in absorption, whereas they are not observable in emission).

The last ten chapters are concerned with the optical instruments used for the examination of the structure of spectral lines. A comparison is made between four instruments, the Fabry–Perot etalon, the Lummer–Gehrcke parallel plate, the echelon grating and the ruled grating. The general superiority and greater scope of the etalon is rather understated, and a quantitative comparison of the intensity of the spectra given by these instruments should not have been omitted. The detailed description of two methods, sputtering and evaporation, for preparing the metallic layers for the plates of an etalon is misleading; the impression is given that the former is a method which would still be used, while it has, in fact, been rendered obsolete by the latter. Though very few, and contradictory, measurements are available concerning the reflecting power of transparent layers of silver and aluminium, this property is made the basis of six different graphs, thus giving a wrong idea of the facts. The most important part of all of these curves, that referring to dense layers as actually used, has been reproduced from data which do not pretend to a high degree of accuracy, and is unfortunately badly wrong. Thus as a consequence of conclusions drawn from the curve giving the relationship between the reflecting power of a layer of silver and the intensity of the maxima of the fringes, it is stated: "The curve has a steep fall in the important region of 0·85 upwards. It is significant to note that an increase in reflecting coefficient from 0·85 to 0·87 (only two per cent) leads to a 50 per cent reduction in intensity. . . . The region in the neighbourhood of the 0·85 reflecting coefficient is therefore highly critical and considered judgment is necessary in preparing such films." If the curve had been drawn correctly it would have shown that the rapid fall in intensity occurs when the reflecting power becomes greater than approximately 0·95. The use of silver layers of this higher reflecting power is of the greatest importance, since it involves an increase by a factor of three in the resolving power and a reduction by a factor of approximately ten in the intensity of the background. The production of evaporated layers of the correct density is necessary for obtaining high resolving power without loss of intensity, and this can be done without the need of "considered judgment" by photo-electric measurement of the density during the course of the evaporation (using the correct value for the reflecting power); but this method is not described.

In the chapter concerned with the compound etalon, too much space is given to theoretical calculations of the properties of this instrument; a description of some of the results which have been obtained and an account of the experimental details of the methods of adjustment would have been of more value. In the discussion of the limitations with regard to the intensity of the fringes and the strength of the subsidiary maxima, the value of this instrument is much underrated on account of the assumption of wrong values for the reflecting power of silver layers and the corresponding intensity of the fringes, taken from the incorrect curve referred to above. A reflecting power of 0·8 is assumed; in fact, a reflecting power of 0·9 can be used without serious loss of intensity; there is then a reduction of the intensity of the subsidiary maxima to a small fraction of that for a reflecting power of 0·8.

The description of the echelon grating lacks an account of the work which has been done with this instrument, and fails to emphasize the importance of its limitations due to the weakness of the spectra as a result of the need for an objective of very long focal length; the advantage of the simplest form of mounting which reduces loss of light are thus underestimated. The discussion of the aberration which would be introduced by this mounting if an objective of short focal length were used is irrelevant, since the limitations due to the grain of the photographic plate preclude the use of a short focal length.

The scope of the photographs at the end of the book is rather limited, since the author has not reproduced photographs made by other workers.

Although serious errors and omissions reduce its value, this book contains much information useful for workers in high-resolution spectroscopy concerning which no comprehensive treatise has hitherto been available.

D. A. JACKSON

CENTENARY OF THE CHEMICAL SOCIETY

THE Chemical Society is entitled to be congratulated on the whole programme of events arranged in celebration of its centenary during July 15–17. There were receptions and a programme of visits, and three excellent lectures besides the centenary address, all appropriate and all well arranged, and many of them displaying the same leading ideas that marked the opening ceremony and the centenary address. The first official function was indeed the opening of an exhibition illustrating one hundred years of British chemistry at the Science Museum, South Kensington, by the president of the Society, Prof. C. N. Hinshelwood, on July 14. The Minister of Education, who took the chair at the opening ceremony, emphasized not merely the vital place of the learned societies in the cultural and educational life of the community and the landmarks in the progress of chemical science to be seen in the exhibition, but like Prof. C. N. Hinshelwood, the dependence of such achievements upon men of independent, vigorous and original minds in the past.

Prof. J. Read, in his lecture at the Institution of Civil Engineers on "Chemical Personalities a Century Ago" on July 16, took a longer look at some of the founders of modern chemistry, and Prof. E. K. Rideal, lecturing simultaneously at the Royal Institution on "The Work of the Royal Institution in Physical Chemistry in Great Britain", also paid tribute to many honoured names such as Humphry Davy, Faraday, Dewar, Sir William Bragg and Sir Henry Dale. Equally, Sir Robert Robinson, in the Faraday Lecture delivered in the Central Hall, Westminster, on the afternoon of July 16, on "The Development of Electrochemical Theories of the Course of Reactions of Carbon Compounds", linked modern ideas on the electrolytic dissociation of acids and the applications of these principles to the benzene ring and theory of partial valency with the work of Faraday, in whose laboratory at the Royal Institution during Faraday's active experimental life of some forty years, fifteen major investigations were undertaken, all of which had a profound effect on physical chemistry as we know it to-day.

The dominant impression left by Prof. Read's lecture was exactly that of the international unity and fellowship which was such a distinctive feature of the dignified and impressive opening ceremony of the celebrations in the Central Hall the previous day. Prof. Read showed how those chemists who founded the Society formed part of a movement which recognized national frontiers no more than the wandering scholars of the Middle Ages, and which even then was throwing up schools of chemistry which attracted men from all over the civilized world. The birth of the Chemical Society was the outcome of an intellectual ferment as international in character as the gathering which saluted its birth. Prof. Rideal's lecture, on the other hand, illustrated incidentally the reciprocal influence of the Chemical Society on other scientific societies and institutions. The Chemical Society, as Sir Robert Robinson pointed out, in conveying greetings to the Society from the Royal Society and the other learned societies of Great Britain, had not merely stimulated the formation of other bodies such as the Biochemical Society and the Faraday Society, but had also contributed to the advancement of knowledge in many diverse fields, as was illustrated by that with which the Society of Dyers and Colourists was concerned. The influence, as Prof. Rideal noted in commenting on the fact that five of the professors in the Royal Institution had been presidents of the Chemical Society, was reciprocal, and the Chemical Society owed much to the labours of other societies.

The names in the list of some forty societies and institutions in Great Britain on whose behalf Sir Robert Robinson offered felicitations to the Chemical Society testified to the ramifications of chemical science during the century and to the industries which had been stimulated or transformed by chemical enterprise, and the proceedings on the Tuesday, above all at the opening ceremony and the centenary address, seemed to epitomize the essential spirit of the celebrations. There was colour as well as dignity in the processional entry of the delegates representing overseas Societies, headed by the president, and preceded by the Society's mace-bearer. The president's words of welcome to the representatives of nearly thirty countries were well chosen, touching briefly on the unity of science. Prof. Raymond Delaby, speaking on behalf of these delegates, responded in French. The addresses formally presented by these delegates and by the representatives of British Societies were not read at the meeting but were displayed in the Society's rooms at Burlington House, where they were to be seen at the Royal Society's reception. Mention might be made here, however, of the Swedish glass vase bearing suitable inscriptions and illustrations of chemical equipment which contained the address of the Chemical Society of Stockholm.

If the centenary address of Prof. Hinshelwood on July 15 is given pride of place it is only because it gave fuller expression to the charm of manner and keenness of thought which marked his tenure of the presidential chair throughout the celebrations. If the founders of the Society might have found it beyond their wildest dreams to expect that the head of the Government of the day would honour the Society by his presence at the centenary dinner and that the fellows of the Society and the overseas delegates should enjoy Government hospitality at the luncheon on July 15 and the garden party at Lancaster House on July 17, the explanation is at least in part to be found in the president and those like him who have linked to their scientific attainments such charm and courtesy and organising ability. That much at least can be glimpsed in his centenary address, which will worthily commemorate the celebration long after the memory of the social events and festivities is dim.

Touching briefly on the philosophical questions raised by the celebration of the centenary not of a discovery or of a person, but of a Society, he reviewed in succession the chemical scene at the foundation of the Society and at successive intervals of a generation before, attempting to discern the essential trends to which great events and personalities are related more as occasions than as causes. Here Prof. Hinshelwood challenged thought about some of the central

issues of our time and formulated our task of preventing an organised society from turning individuals into slaves with all the implications for the relation of the State to science, of industries to the universities, for the organisation of research laboratories and, indeed, for the relation of every scientific worker to the laboratory in which he works and to the science as a whole. Complete individualism means chaos, but it is still the individual who counts; but his problems are different, and at every level in every organisation where men engaged in scientific pursuits those in charge must continue to wrestle with the problems of combining liberty with order to the end of finding that course which is humanly as well as technically the most effective.

Pragmatic as well as suggestive, Prof. Hinshelwood was never doctrinaire, but he did not hesitate to follow his words of appreciation for the increasing number of scientific papers coming from chemical industry, with a warning of the dangers in which military security might involve us or against the restrictions on scientific publication imposed by paper stringency or to plead for adequate facilities for meetings, and in this address he returns in conclusion to the international character of the Society and to the fellowship of those who share the love of chemistry which was so manifest at the celebrations.

Welcome as may be the generous appreciation of the work of the Society manifest in the addresses of felicitation, the hospitality extended to its fellows and guests at the receptions, visits and social functions, it is to the spirit which pervades the centenary address that we must look chiefly for the firm assurance that the second century on which the Society has entered will be no less noteworthy than that celebrated in July 1947.

ELEVENTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

THE Eleventh International Congress of Pure and Applied Chemistry was held in London during July 17–24, following immediately on the centenary celebrations of the Chemical Society. Some three thousand members and delegates, including many leading personalities in all branches of chemistry, and representing thirty different countries, took part in what must have been the largest international gathering of men of science since the end of the War. A crowded programme had been arranged, consisting of meetings for the reading and discussion of papers, lectures, visits to industrial laboratories and many social events.

More than 1,500 papers were submitted for presentation. For the purpose of reading the papers selected, the Congress met in fourteen sections, representing the various branches of pure and applied chemistry. Several sessions were held jointly between different sections, and the majority of contributions were in the nature of reviews of work already published, or in the process of publication, rather than entirely new material. It is obviously impossible to give more than a very brief indication of the vast amount of ground covered. Only a small fraction of individual contributions can be mentioned, but it will be useful to summarize the main topics of discussion as they provide an excellent indication of contemporary trends in chemistry.

In Section 1 (Inorganic and Geochemistry) the first session was devoted to reactions in solids and X-ray methods, and included a general review by J. A. Hedvall of progress in this field over the last thirty years, and an account by H. L. Riley on the X-ray crystallography of amorphous carbon. At a later session, entitled "Structural Chemistry of Metals and Inorganic Compounds", L. Pauling outlined a new theory of the metallic state. Treatment of interatomic forces in metals by the method of atomic orbitals provides a qualitative explanation of the special properties of the transition metals. Other speakers discussed recent work on the structure of mixed crystals (P. Niggli), molecular compounds (H. M. Powell) and electron-deficient molecules (R. P. Bell). Further sessions dealt with geochemistry and the structure of minerals, and with radiochemistry, and included papers on francium (element 87) (M. Perey), and on protactinium (G. Boussieres and H. Haissinsky). The disappointing fact that any direct reference to subatomic phenomena was excluded, brought to mind the centenary address of the president of the Chemical Society in which he expressed the hope that "the whips of commercial secrecy would not be succeeded by the scorpions of military security" in preventing the publication of research.

In Section 2 (Physical Chemistry) there were symposia on polymers, catalysis and reaction-rates, and spectra. The latter was almost wholly concerned with the absorption spectroscopy of organic compounds. The striking developments in the technique and applications of measurements in the infra-red region were reviewed by J. Lecomte, G. B. B. M. Sutherland and H. W. Thompson. E. Clar discussed the ultra-violet light absorption of aromatic hydrocarbons, and J. M. Robertson the determination of bond-length by X-ray methods. In the session on polymers, held jointly with the Textile and Elastomers Sections, about an equal number of papers were devoted to structural and kinetic aspects. H. W. Melville described the synthesis and properties of a new branch-chain type of polymer built up from cruciform and star-shaped molecules and obtained by condensing together adipic acid, ethylene glycol and a small amount of a polyfunctional alcohol, such as penta-erythritol. Two papers by H. Mark dealt with the mechanism of polymerization reactions and the configuration of polymer molecules. The composition of a binary co-polymer is related to the electron-availability at the radical end of the growing chain and at the double bond of the monomer molecule, and can be predicted from the electronic character of the substituents. J. B. Speakman described the modification of the properties of natural fibres by chemical means, for example, by successively breaking and re-uniting the cysteine cross-linkages in keratin with reducing and oxidizing agents, and by physical means. Among the topics covered in other sessions were those of mass-spectrometry, magneto-chemistry and polarography, and included papers on the measurement of the rate of electrode processes by oscillographic methods (J. Heyrovsky), the thermal and photo-oxidation of olefins (I. Bateman and J. L. Bolland) and the absolute velocity of contact catalysis (G. H. Schwab).

The programme of Section 3 (Organic Chemistry) covered general organic chemistry, heterocyclic compounds, antibiotics, vitamins and growth factors,

and theoretical organic chemistry, and included many contributions of outstanding interest. Of special significance from the international point of view was an account by G. M. Dyson of his new system of notation for organic compounds, which has many advantages over the rather loose nomenclature at present in use. Any compound, however complicated, can be ciphered uniquely, the number of symbols required being on the average less than half of those used with the Geneva Convention, and the ciphers are admirably suited for mechanical indexing and sorting methods. Five papers on penicillin by H. C. Carrington, K. Folkers, Sir Ian Heilbron, D. Crowfoot Hodgkin and V. du Vigneaud, and their collaborators, provided a fascinating story of what is probably the greatest concerted effort yet made by organic chemists. Of the two rival thiazolidine-oxazolone and thiazolidine-β-lactam structures, the latter is now accepted, mainly on the basis of physical evidence; but the only definite synthesis so far achieved, though in minute yield, is based on the former. The synthesis of vitamin A, a goal which for so long defied the attempts of several groups of workers, was announced by D. A. van Dorp and J. F. Arens (see also *Nature* of August 9, p. 189), and by O. Isler. The determination of the constitution of streptomycin was outlined by K. Folkers. Sir Robert Robinson discussed recent work in the strychnine group of alkaloids. The isomerization of strychnine into neostrychnine has been recognized as a simple prototropic rearrangement, and leads to a new structural formulation. Other notable contributions included the synthesis of compounds related to the auxins (E. R. H. Jones) and to pyridoxin (vitamin B_6) (A. Cohen), degradative work on amyrin (L. Ruzicka), the potato eelworm hatching factor, ecleptic acid (A. R. Todd), and testosterone (P. A. Plattner), the constellation of many-membered ring ketones (V. Prelog), and of the configuration of the hydroxyl group in cholesterol (C. W. Shoppee), the synthesis of pyrimidines (F. H. S. Curd and F. L. Rose) and of xanthines (F. S. Spring), and addition reactions of nitro-olefins (J. D. Rose), and of halogen-containing compounds to olefins (M. S. Kharash). Theoretical organic chemistry was represented by papers on the kinetics and mechanism of aromatic nitration (C. K. Ingold) and halogenation (J. P. Wibaut), the mechanism of oxidation reactions (W. A. Waters), the X-ray analysis of cyclo-octatetrene (H. Mark), and others.

In Section 4 (Biochemistry) there were sessions on enzymes and enzyme action, macromolecules of biological interest, intermediary metabolism, and proteins and protein analysis. J. D. Bernal spoke on the structure of the protein molecule, a picture of which is now slowly emerging by the combined attack of electron microscopy, X-ray and chemical analysis. F. Sanger described a new method of estimating the length of polypeptide chains in proteins and of identifying individual amino-acids by reacting the free amino-groups with 2 : 4-dinitrophenylfluoride, and separating the coloured derivatives by partition chromatography. M. Stacey gave an account of bacterial polysaccharides and H. N. Rydon described studies which indicate that hydrogen-bonding may be an essential feature in the combination of bacterial enzymes with their substrates. The emphasis in metabolic studies was on the use of isotope tracers. V. du Vigneaud presented evidence that only the sulphur but not the carbon of methionine is used in the synthesis of cysteine in rats. Studies employing radioactive phosphorus and iron indicate that there is a rapid migration of phosphorus from the plasma into the red blood corpuscles, and that average lifetime of the latter is about one month in the hen and four months in man (G. von Hevesy). The fate of mustard gas in the animal body and the mode of action of B.A.L. (British anti-lewisite, 2 : 3-dimercaptopropanol) has been investigated using radioactive S^{35} (G. E. Frances and A. Wormall, L. Young). M. el Shahat announced the discovery of a new 'H'-lactation promoting factor which is not a tocopherol.

Sections 5 and 6 (Chemistry in Relation to Agriculture and Applied Botany, and to Applied Zoology and Veterinary Science) held symposia on soil fertility, plant nutrition and fertilizers, animal nutrition, composition and quality of milk, insecticides and fungicides, and the chemotherapy of protozoal infections. Several speakers, among them H. R. Marston, R. L. Mitchell, S. A. Waksman and E. J. Underwood dealt with the role of trace elements, such as copper, selenium and cobalt, a subject on which very diverse views are still held in different countries. J. H. Quastel described his recent work on the role of manganese in biological oxidation in the soil. S. J. Rowland reported a steady decline in the solid protein content of English milk, and seasonal variations in the composition of milk in Norway and India were discussed by G. Aas and K. C. Sen. H. Hurst attributed the mode of action of D.D.T. to the indirect blocking of the cytochrome oxidase and succinic dehydrogenase systems by the storage of insecticide in the phospholipoids of the cell membranes, while H. Martin directed attention to the parallelism between the ease of dehydrochlorination and insecticidal activity in D.D.T. analogues. The chemotherapeutic uses of amidines and of phenanthridinium compounds were reviewed by H. J. Barber and by L. P. Walls.

In Section 7 (Chemistry in Relation to Food and Nutrition) Sir Jack Drummond introduced a topical discussion on the effects of dietary restrictions in man. J. R. Marrack, in dealing with the question of how can we know whether our food is doing us good, considered that the most reliable answer was provided by functional tests, for example, the level of hæmoglobin and ascorbic acid in blood, and the height and weight of children, rather than by vital statistics. A. Neuberger introduced a discussion on the role of amino-acids in nutrition. Isotope tracer experiments have established the extraordinary speed of nitrogen exchange between proteins and the dietary supply. Experiments which establish the function of methionine as a source of labile methyl groups were described by V. du Vigneaud and by L. E. Glynn. D. P. Cuthbertson discussed the marked catabolism of body protein following traumatic injury as revealed by the losses of nitrogen and sulphur in the urine.

Section 8 (Chemistry in Relation to Medicine and Therapeutics) covered a wide range of topics. Sir Howard Florey introduced a symposium on antibiotics. The rapid developments in this field are exemplified by the isolation from actinomycete cultures of more than a dozen antibiotics besides streptomycin (S. A. Waksman), and the production of a variety of compounds effective against *M. tuberculosis* by *Fusaria* (A. H. Cook). In a session on industrial toxicology, B. C. Saunders reviewed the toxic properties of fluorine compounds such as the fluorophosphonates and fluorocarboxylic acids $F.(CH_2)_n.CO_2H$. The latter are harmless when n is even, but toxic when n is odd. R. A. Peters discussed the

reactions of B.A.L., and R. Spence and A. G. Maddack outlined the design of a radiochemical laboratory in relation to the protection of the health of the staff. Two further sessions, entitled "Endocrinology and Carcinogenesis" and "Drugs and Chemotherapy", included papers on doisynolic acids (K. Miescher), œstrogens related to triphenylethylene (W. Tadros), carcinogenic agents of the *p*-aminostilbene type (G. A. R. Kon), the relation between physico-chemical properties and bacteriostatic properties of acridines (A. Albert) and the empirical and rational approach to chemotherapy, as exemplified by the work culminating in the discovery of the antimalarial paludrine (F. H. S. Curd and F. L. Rose).

In Section 9 (Chemistry in Relation to Fuel, Power and Transport) there were discussions on many aspects of the production of solid and liquid fuels, carbonization and gasification, and combustion. Among topics which attracted special attention were gas turbines and underground gasification. Sir Ernest Smith addressed a meeting on the training of chemists for the fuel industries. In Sections 10, 11 and 12 (Chemistry in Relation to Natural and Artificial Textiles, to Elastomers, Plastics, Glass and Ceramics, and to Metals) the predominant tendency was towards fundamental investigations as an aid to the solution of practical problems. The academic approach was typified by contributions on the properties of seaweed rayon (J. B. Speakman), deuterium exchange in cellulose (H. Mark), the theory of crystallization and plastic flow (Sir Lawrence Bragg), the intrinsic viscosity of polymer solutions (P. Debye), the effect of crystallization on the mechanical properties of high polymers (G. Gee), the network theory of rubber (W. Guth and H. M. James), sorption kinetics (R. M. Barrer), the thermodynamics of metallurgical extraction processes (H. J. T. Ellingham), and the electrochemical mechanism of corrosion (U. R. Evans). Section 13 (Chemical Engineering) held a symposium on educational aspects, as well as discussions on a variety of large-scale processes, including the production of hydrogen, oxygen, heavy water and toluene.

In addition to the section meetings, Congress lectures were delivered by L. Pauling on "Molecular Structure and Biological Specificity", Sir Henry Dale on "The Part of Chemistry in the New Therapeutics", P. Karrer on "Recent Advances in Organic Chemistry", A. Tiselius on "Recent Developments in Electrophoresis", L. Hackspill on "Calcium Carbide and its Reducing Properties", and by B. C. P. Jansen, who took as his subject "*Simplex non veri sigillum*".

The second, equally important function of the Congress, namely, to promote and extend the invaluable personal contacts between chemists of different countries, was well provided for. Delegates and members were entertained by the Government, the Royal Society, the Royal Institution, the Chemical Society, the Royal Institute of Chemistry, the University of London, Imperial Chemical Industries, the English Speaking Union and other bodies. There were two Congress dinners, one of which was attended by the Prime Minister and Mrs. Attlee. In proposing the toast of chemistry, Mr. Attlee said that the problem of the modern world was not how to make more advances in science, to which it owed so much, but rather, how to secure a world in which those advances could be made with safety. This indeed must have been the predominant thought of all those who took part in this Congress.

SEVENTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS

THE Seventeenth International Physiological Congress was held in Oxford during July 21–25 under the presidency of Sir Henry Dale. It was attended by about 1,200 physiologists, including welcome delegates from the U.S.S.R. and China. The official programme was very heavy, for 350 communications, about seventy demonstrations and a number of films had to be compressed into three working days.

There were a number of excellent films, including one of hypothalamic stimulation by W. R. Hess, the isolation of a single nerve fibre by A. von Muralt, perfusion of the whole animal by I. de Burgh Daly, and colour films for teaching made with the help of Imperial Chemical Industries, Ltd., by J. H. Burn and F. R. Winton.

In earlier international congresses, it was intended that communications should be demonstrative and experimental, and memorable demonstrations have included one by Sherrington on the reciprocal innervations of antagonists, and another by Mering and Minkowski on the experimental production of diabetes. This year the demonstrations were interesting and competent, but not, perhaps, of the first importance.

For the communications, nine lecture theatres were in use simultaneously during the six sessions. This permitted the programme to be completed without trespassing on the time available for the all-important social activities, and their opportunities for personal contact.

A considerable number of communications arose from work undertaken with official encouragement in the War. Studies on respiration at high altitude, at high pressures of oxygen and carbon dioxide, explosive decompression, resistance to centrifugal force, resistance to high environmental temperature, all demonstrated the practical usefulness of physiological analysis.

Studies which were made possible by the development of new substances during the War, or which arose out of the care of war casualties, were on the whole of greater scientific importance. The application of di-isopropyl-fluorophosphonate to a variety of systems involving acetylcholine, and further controversy over the part played by acetylcholine in the transmission of the nerve impulse, the application of B.A.L. to the treatment of poisoning by arsenic and other metals, are good examples. Work on patients suffering from starvation, traumatic arteriovenous aneurysms and traumatic paraplegia has also been not unprofitable.

Perhaps the most important work reported, however, has been in independent research, in which, in Prof. E. G. T. Liddell's phrase, after seven years, members were showing an active post-inhibitory rebound. An outstanding paper was given by A. L. Hodgkin and A. F. Huxley, who suggested that during the rising phase of the action potential in nerve, the membrane becomes highly permeable to sodium ions which then enter the cell. Potassium ions leave the cell during the falling phase and later restorative processes occur linked with energy-producing mechanisms. There was considerable indirect evidence in favour of this view. A theoretical treat-

ment of the principal events in muscular contraction was put forward by A. Szent Györgyi, and provoked a vigorous discussion (see also p. 262).

The refinement of physical methods applicable to living organisms has progressed rapidly. Methods of measuring tissue fluid flow by radioactive helium, recording the contour of the heart by a precise radiographic and photo-electric method, continuous records of blood pressure in man by a condenser manometer, all provide powerful tools for work on the circulation. The clinical physiologists, A. Cournand, J. V. Warren, E. A. Stead, J. McMichael and E. P. Sharpey Schäfer, using cardiac catheterization, have demonstrated the similarities as well as the differences in the behaviour of the circulation in man and in anæsthetized animals.

The nature of the proteins of muscle and of the nucleus and its chromosomes has continued to occupy much attention. The central nervous system also was the subject of a large number of papers; but there were no outstanding advances in any of these fields.

The Congress accepted an invitation to Copenhagen for the Eighteenth International Congress, to be held in 1950, under the presidency of Prof. August Krogh.

On the last day, the University of Oxford conferred degrees of Doctor of Science on Profs. C. H. Best, H. S. Gasser, B. A. Houssay, August Krogh and A. Szent Györgyi.

GRASSLAND AND ANIMAL PRODUCTION

IN July 1937 the International Grassland Conference was held in Great Britain, and the delegates examined closely the work and promise of the Aberystwyth nucleus, from which so much of the newer knowledge and philosophy of grassland management has spread. In the last week of June 1947, a further review of the activities of the Welsh Plant Breeding Station was made by members of the British Grassland Society and the Society of Animal Production at the first joint meeting of the two groups. This occasion, too, was given a minor international flavour by the representatives from countries overseas, who took the opportunity to refresh their contacts with workers in Britain; but, useful as this was, the greater significance of the meetings and visits lay in the interchanges of ideas and comments between those concerned on one hand with better grassland and, on the other, with better use of that grassland by the animal.

At first glance, there should be no divergence between the two aspects; clearly, however, there is. Moreover, there might appear to be a close parallel between the objectives of the animal husbandman and the agronomist: one aims to increase productivity by better nurture, better breeding, and a replacement of the less biologically efficient stock by those of greater and more reliable merit, the other at improving productivity of the plants by broadly similar means. Yet such a parallel would be deceptive as a representation of the past, and even present, courses of the two lines of endeavour.

During the last ten years great progress has been achieved in the development of plant-breeding methods and material. At all stages of the process, from the search for fresh material, its testing, experimental breeding, progeny-testing, and multiplication, to the treatment of seed, and the certification of stocks, as well as in the maintenance of proved stock plants or strains and in the trials of material from other sources in pure cultures and in mixtures, the techniques have advanced even under the difficulties occasioned by war-time shortages of personnel and equipment. The gardens and trial grounds of the Plant Breeding Station at Penglais, with the larger plots and field trials at Frongoch and the multiplication fields at Morfa Mawr, provided the background for a spectacular display by Prof. T. J. Jenkin and his colleagues of the use and application of the old and new methods—to the envy of the animal breeders, who, restricted by the numerical smallness, but physical largeness, of their material, have also to think in terms of populations.

The years of war have accelerated the spread of the selected Aberystwyth strains of grasses and of clovers into practical conditions of grassland establishment. The urge to increased production of British agriculture has given encouragement to ley farming, and the demand for seed of known origin has had repercussions in the seed trade, as well as on the administrative and routine activities of the staff of the Station. At the same time, the principles and methods of improving the swards of the higher and inherently poorer grazing lands, as developed at Llety-Evan-Hen and the Cahn Hill Improvement Scheme, have been given a wider extension to other hill areas, to the enhancement of stock production, as was described by Mr. Moses Griffith and Prof. W. Ellison at the separate meeting of the Society of Animal Production. The prospect of the early discontinuation of the Cahn Hill work is regarded with concern by both Societies, the members of which recognize the important role of the hill farming areas in the maintenance of a healthy and balanced stock-raising industry in Great Britain.

Though somewhat envious of the technical opportunities and material advantages offered to the plant breeders, the stock men were none the less comforted. They found themselves, for example, on familiar though not so clearly signposted country in noting such matters as the variation among the progeny from selected parents and strains, the differential responses of varieties and strains under a common environment and changed behaviour in other environments, the range in maturity, the effects of length of day on reproductive organs, the handiness of 'indicator' characters (but not of necessity their feasibility as measures of performance), change or 'degeneration' in the later generations of stocks grown on in other areas, or even the different potentialities and performances of 'pedigree' and 'commercial' strains. There should be much common ground here for future co-operation in study and discovery of principles, for example, in wedding the ecological approach to the genetical, to enlighten the limits of selection in one environment to meet the demands and suitabilities in another.

The present divergence of views occurs with regard to purpose and method. The emphasis in the grassland work appears, to the animal husbandman, to be on the sward, and its management to the benefit of the sward. The increased productivity of swards, as swards, which can emerge from suitable seeds mixtures, sown under favourable conditions of soils and cultivations, with appropriate fertilizer treatments and apt grazing and cutting, is clearly demonstrable and has, in fact, been often and well demonstrated.

The possible marked extension of the grazing season and the expanded opportunities for conservation of the surplus product of highly valuable protein foodstuff affords hope of a greatly enhanced, even revolutionary, level of animal production. Sir George Stapledon, in a noteworthy address, suggested a ten-year plan for more livestock to utilize his envisaged 9 million acres of leys and 4 million acres of permanent grass against the present 10 million permanent and 3 million leys—and asked for guidance as to numbers, kinds and quality for this target. Yet he, adding his emphasis to that offered by many of the demonstrations, recognizes the extraordinary niceties of reaction of the plant strains and mixtures to all points of management, and implied doubts whether a suitable technique of testing the absolute value of the pastures can be derived unless they are grazed at different intensities of grazing, and admitted that at times, for suitable conditions of conservation of surplus growth, drastic treatment by cutting has to be adopted.

The main use of grassland is for grazing—but that platitude over-simplifies many of the real issues. Experimentally it may justify using the grazing animal to measure pasture productivity in terms of live-weight increase or milk yield, which terms achieve an apparent validity since they are involved in economic or practical returns. However, it has also been clearly shown that grazing in itself is a powerful factor in altering the composition and 'utility' of the grazed pastures. Pasture management has long been realized to involve control of the biotic factor, but from the animal physiologist's point of view the nature of this complex influence is by no means sufficiently understood for it to be used as anything more than a very general and indirect measure of productivity. This is especially the case when there is a dearth of experimental evidence on the important question as to how far the very conditions of restraint, implied in using animals to graze small plots under trial conditions, themselves affect the animals' reactions, behaviour, growth, development and output, as of live-weight.

The ultimate purpose is to translate experimental results into farm practice. This introduces another set of, as yet, imponderable factors. The field is a unit only in so far as it is part of the farm; the grazing animal also is part of a herd or flock. For the farm as a whole—even for the country as a whole—the supply of winter feed is the limit to production; to widen this restriction, forage crops and conserved grassland in the form of silage or dried grass offer prospects of greater development. But a better and more efficient alternative in present circumstances, in Dr. John Hammond's view, might be to utilize the high production of the summer months for cheaper summer fattening, and to conserve and store the animal product rather than the grass. Again, the numbers of animals on a farm are relatively fixed over long periods; under practical conditions, especially in these days of self-contained dairy herds, the farmer cannot arrange the timing or intensity of grazing to meet those niceties of management which the grassland expert dictates as optima for the good of the sward. As Prof. W. C. Miller suggested, the complex situation of stocking and stock-management may require more complex mixtures of grazing constituents to provide pastures which can be practically mismanaged with safety, rather than a multiplicity of mixtures and treatments, each needing specific control to evoke their best response.

So long as conditions vary from farm to farm, field to field, and season to season, the principles of stock and grazing management must be allowed very flexible application. Even those of rotational grazing, with subdivision of the areas into smaller units, particularly in so far as it involves the human factor of judgment of pasture productivity, are not fully understood, as the plots at the College Farm at Nantcellan show. The formal and informal discussions at these meetings proved that a great deal of endeavour remains to be applied to the problems of the pastures we grow, the uses to which they can be put, and our methods of using them—and that any mutually exclusive interpretation of the results of experiment and observation by animal and grassland specialists is no longer admissible.

J. E. NICHOLS

THE RADIATIONS FROM THE EARTH'S ATMOSPHERE

IN the latitudes of London, Paris or Washington the appearance of an aurora borealis is somewhat infrequent and finds few investigators prepared with equipment for detailed observation. Most of the work on the location and spectra of aurora has therefore been done at such places as Tromsø, which are within the main auroral belt: our knowledge of the phenomenon is mainly due to Størmer and Vegard, and their collaborators. The principal progress has been achieved in the present century, and especially in the last ten or fifteen years. It has only been rendered possible by the rapid general advances in physical techniques and equipment.

During the first quarter of this century, it began to be recognized that at all latitudes the night sky is appreciably luminous even in the absence of the moon. This effect is partly due to radiation from the stars, both those individually visible and those much more numerous stars too faint to be detected by the unaided vision; the zodiacal light, which is of the nature of scattered sunlight, also makes a contribution. But the major part of the luminescence originates in the atmosphere itself: its spectrum shows a complex set of emission lines and bands against a continuous background. The intensity is very low, so the observational work is extremely difficult. Slipher, who was among the first to study the spectrum of the night sky light, discovered that a permanent component of it is the famous green line previously known to be prominent in the auroral spectra. Rayleigh, who used characteristically simple methods, devised and carried out, partly with the aid of observers overseas, a many-sided programme of observations. By means of filters he distinguished three different spectral regions and studied their geographical distribution and their temporal variations. He even measured the absolute intensity of the green line: the number of photons he found to be emitted in a square centimetre column of atmosphere is about 2×10^9 per sec. This remarkable pioneer work gave results of lasting value.

The problem of the identification of the green line was solved by McLennan and his colleagues who, in the years 1925–27, showed that it arose from atomic oxygen and is due to what is called a forbidden transition—that is, one that violates the normal selection rules and is only possible because of their approximate nature. Now the emission of the green-

line radiation does not bring the oxygen atoms involved to their ground-state; it instead brings them to the lowest excited state. In final passage from this state, radiation may be emitted corresponding to certain red lines. These have now been found both in the night sky and auroral spectra. It is possible that the forbidden lines of atomic nitrogen are also present.

More recently, in 1938, there came from France the astonishing news that sodium occurs in the high atmosphere in the free atomic form. Proof for this was provided by the identification of its characteristic yellow line (or rather doublet).

In addition to the atomic lines a large number of bands appear. Those in the spectra of auroras can be ascribed mainly to neutral and singly ionized molecular nitrogen. Much work has yet to be done on the interpretation of the night sky spectrum; but it seems probable that the principal contribution to the visible region is from neutral molecular nitrogen, and the principal contribution to the ultra-violet region is from neutral molecular oxygen: the bands of singly ionized molecular nitrogen seem to be normally absent. An interesting discovery, made in 1942 by Herman, Herman and Gauzit, is a remarkably strong emission in the infra-red region: its identification is still in doubt.

A growing number of highly skilled observers have been drawn into this branch of research and have obtained many unexpected and varied results. These have aroused the interest of geophysicists, astrophysicists, laboratory spectroscopists, theoretical physicists, radio scientists, chemists, and mathematicians. One manifestation of this interest was an international conference on the "Emission Spectra of the Night Sky and Auroras" organised under the auspices of the Gassiot Committee of the Royal Society and held in the Society's rooms at Burlington House, London, during July 7–10.

The Gassiot Committee is charged with the supervision and planning of a long-term programme of research on the radiation in the atmosphere and on related phenomena. This commitment was undertaken at the request of the Air Ministry (on the advice of the Meteorological Research Committee). Financial aid is given by the Ministry. The initiative in proposing the conference was taken by Prof. H. S. W. Massey, chairman of one of the sub-committees appointed by the Gassiot Committee to deal with different sections of the general programme.

The conference was attended by guests from Belgium, France, Norway, Sweden and the United States, and by many from the British Isles. Russian scientific workers have done much work in the field concerned, but none was able to be present: the Embassy, however, sent an observer. The papers read at the conference will be published by the Physical Society in the next issue of its "Report on Progress in Physics". Here only an outline of the ground covered will be attempted.

The best recent observations of the night sky spectrum have been made in France and the United States. Papers describing the results were contributed by G. Dejardin, J. Dufay, Tcheng Mao-Lin, A. and E. Vassy, R. Grandmontagne, C. T. Elvey and E. O. Hulburt. There was considerable discussion of the altitude of the luminous region, which is still very uncertain. Much attention was given to the special character of the spectrum at twilight, when the negative bands of nitrogen, the red lines of oxygen, the yellow doublet of sodium and possibly other components are enhanced. A. Kastler described work by J. Bricard and himself on the polarization of the light of various atomic lines using a very simple polariscope due to Savart and improved by Lyot. The green oxygen line was found to show less than 3 per cent polarization—a result to be expected from theory, but contradicted by recent measurements in the U.S.S.R. D. Barbier, R. W. B. Pearse and others discussed the identification of the spectral components. A great deal of time was devoted to the complex and fascinating task of explaining the cause of the emission. D. R. Bates, H. S. W. Massey, and M. Nicolet contributed papers relating to this problem. It seems probable that the emission is due in part to the dispersion of the energy stored up by the dissociated oxygen (and perhaps also nitrogen) formed during the day: recombination of the charged particles in the ionosphere will play a minor part. Consideration has also to be given to the suggestion that incident particles may have to be invoked to explain such effects as the irregularity of the light. Much remains to be elucidated. P. M. S. Blackett presented an interesting paper on the possibility of cosmic rays making an observable contribution to the continuum through Cerenkov radiation.

Recent observational work on auroras was reported by G. Kvifte (on behalf of L. Vegard) and by R. Bernard. Confirmation was given to the suggestion that hydrogen and helium may be present. An important new analysis of the spectrum was given by M. Nicolet. K. G. Emeléus read a paper sent by J. Kaplan describing laboratory experiments on the reproduction of the characteristic emissions.

It is generally accepted that auroras are due to the action (direct or indirect) of charged particles guided pole-wards by the earth's magnetic field. However, the nature, origin and energy of these is still the subject of controversy. Widely different views were expounded in papers by H. Alfvén, S. Chapman, and F. Hoyle.

One session of the conference was devoted to a discussion, led by R. W. Ditchburn, on the instruments and techniques of observation. E. O. Hulburt gave a valuable account of the work being done in the United States on the exploration of the upper atmosphere by means of rockets.

S. CHAPMAN
D. R. BATES

OBITUARY

Prof. J. Perner

THE death occurred at Prague, on June 9, of Dr. Jaroslav Perner, professor of palæontology at the Charles University. Born at Tynec-nad-Labem on March 28, 1869, Perner claimed to be a pupil of the French geologist, Joachim Barrande (1799–1883), in whose footsteps he followed by continuing the investigation of the fossil fauna of the Silurian and Devonian rocks of middle Bohemia. His studies were incorporated in various publications, including "Système silurien du centre de la Bohême" and a work of four volumes entitled "Études sur les graptolites de Bohême". Most of his other publications were in Czech or German.

Early in life Perner came to England and spent a period in the 'nineties at Mason College (afterwards the University of Birmingham) working under the late Prof. Charles Lapworth. J. G. F. D.

NEWS and VIEWS

The Royal Society of Arts

H.R.H. THE PRINCESS ELIZABETH has graciously accepted the invitation of the Royal Society of Arts to become its president. The Royal Family has been closely connected with the Royal Society of Arts for more than a hundred years. Prince Albert became the Society's president in 1843, and in that capacity initiated the Great International Exhibition held in Hyde Park in 1851. Other Royal presidents have been Their Royal Highnesses the Prince of Wales (later King Edward VII), the Prince of Wales (later King George V) and the Duke of Connaught.

The British Museum (Natural History)

Sir Clive Forster-Cooper, F.R.S.

SIR CLIVE FORSTER-COOPER will retire from the post of director of the British Museum (Natural History) on September 30, after ten arduous years of office, and a much longer period spent in the service of museums and libraries. His active interest in museum problems goes back to the days when, as a young man, he studied in the American Museum of Natural History under the late Prof. H. F. Osborn; but he was not connected with a museum in an official capacity until some years later. In 1914 he became superintendent of the University Museum of Zoology, Cambridge, and immediately began a much-needed reorganisation. By dint of drastic pruning and rearrangement, he transformed an old-fashioned teaching collection into a modern museum well adapted to the changed conditions after the First World War. During this period, Mr. Forster-Cooper was elected a syndic of the FitzWilliam Museum, and also to the University Building Syndicate of which he ultimately became chairman. The scheme for a new university library had its origin in a suggestion which he made soon after his election to the latter body.

When the Principal Trustees appointed him director of the Natural History Museum in 1938 he began to replan the exhibition galleries, and here his long experience in Cambridge was of great value. For the first year all went well, and important experiments in exhibition technique were carried out; but the international situation gradually became more threatening, and early in 1939 all these plans had to give way to others for the evacuation of the collections and libraries, and to general precautionary work. These tasks were scarcely finished when air raids on London began. In quick succession the roofs were burnt off the Herbarium and the Shell Gallery, and further damage was done to the building by high-explosive bombs. All the time that the Director was dealing with the day-to-day hazards of war, he was laying his plans for the future. They were summarized in a memorandum which was adopted by the Trustees as a basis for future action, although any hopes of their immediate realization were dashed when a flying bomb, which exploded in the Cromwell Road in July 1944, wrecked almost the whole of the interior fittings in the front galleries of the Departments of Geology and Zoology. After the War he supervised the return of the libraries and collections, and the reopening of those parts of the ground-floor of the Museum still fit for use. His services received official recognition with the award of a knighthood in the New Year Honours of 1946.

Mr. N. B. Kinnear

MR. NORMAN BOYD KINNEAR, who has been appointed to succeed Sir Clive Forster-Cooper as from October 1, was educated at Edinburgh Academy and Trinity College, Glenalmond. After acting for two years as an assistant, on a voluntary basis, in the Royal Scottish Museum, he became for twelve years curator of the Bombay Natural History Museum and from 1908 until 1919 was assistant editor of the important Bombay Natural History Society's *Journal*. In 1920 he joined the staff of the British Museum as an assistant keeper, and after a period as deputy keeper was, in 1945, appointed to the keepership of the Department of Zoology.

Mr. Kinnear's time in India gave him the opportunity of much work in the field and of acquiring a wide knowledge as a field naturalist of the living fauna of the country in general in addition to his main line of work as an ornithologist. Most of his published work, chiefly in the *Ibis* and the *Journal of the Bombay Natural History Society*, deals with birds, especially the avifauna of the East, as, for example, the birds of the Eastern Ghats, of central south Arabia, Chinese Turkestan, north-east Burma, and south-east Tibet among others.

During the War, in addition to the struggle of keeping the Department of Zoology going under very adverse circumstances, he did signal service first in helping with the evacuation of the Museum's collections to safer places than London and then, after the War, in the complicated business of their return, unpacking and resettlement, work which is still in progress and in present circumstances requires much thought and planning. Mr. Kinnear in 1943 was elected president of the British Ornithologists' Union and is the present chairman of the British Section of the International Committee for Bird Protection.

Science in Scotland

UNDER the title "Science in Scotland", Dr. W. P. H. Wightman gives a very readable account of the development and work of the Rowett Research Institute in Animal Nutrition, the Macaulay Institute for Soil Research, the Moredun Institute of the Animal Diseases Research Association, the Institute of Animal Genetics, the Hannah Dairy Research Institute, the Torry Research Station for fishery research and the Scottish Society for Research in Plant Breeding ("Science in Scotland: the Work of the Scottish Research Institutions", by Dr. W. P. H. Wightman. Published for Scottish Convention. Pp. 56. Stirling: Eneas Mackay, 1947. 2*s*. net). Some of the achievements of these research institutions are indicated, while in a final chapter the foundation of the Seaweed Research Association is noted and the establishment of a Scottish Forest Products Research Station and of a Sea Loch Development Association is suggested. Dr. Wightman is not convinced as to the advisability of separate Scottish institutions for most manufacturing traditional industries, and suggests that the principles guiding the establishment of distinctive Scottish research institutions should be in the main the development of predominant Scottish resources; the special problems arising out of Scottish customs and conditions; the need for economy in time for consultation even at the cost of duplicating overhead charges; and the appeal to national enthusiasm and local interest.

Education in the Royal Air Force

THE Secretary of State for Air has announced that the Air Council has decided to set up an Educational Advisory Council for the Royal Air Force with the following terms of reference: "To keep under review the educational policy for the Royal Air Force and to advise the Secretary of State for Air on such matters connected with education in the Royal Air Force as they think fit and upon any educational questions referred to them by him." The following will, in addition to representatives of the Ministry of Education, the Scottish Education Department, and the Ministry of Labour and National Service, serve on the Council: Dr. Keith A. H. Murray, rector, Lincoln College, Oxford (*chairman*); Mr. Harold E. Clay, president, Workers' Educational Association; Miss M. C. Glasgow, secretary-general, Arts Council of Great Britain; Mr. Ronald Gould, general secretary, National Union of Teachers; Miss V. Holmes, member of the Council of the Women's Employment Federation; Mr. J. C. Jones, director of education, the Polytechnic, Regent Street, London; Air Chief Marshal Sir Edgar Ludlow-Hewitt, R.A.F. (retired); Mr. H. Morris, chief education officer, Cambridgeshire; Mr. J. H. Nicholson, principal, University College, Hull; Dr. D. R. Pye, provost, University College, London; Mr. W. E. Williams, director, Bureau of Current Affairs; Mr. J. F. Wolfenden, headmaster, Shrewsbury School.

Science in the New India

THE presidential address of D. N. Wadia at the thirteenth annual general meeting of the National Institute of Sciences of India, after referring to the ten-acre site which the Institute has acquired for its building and to the organisation and expansion of its secretariat and mentioning the formation of two strong committees to advise the Government on research in the Indian academies, institutes and universities, was devoted to a discussion of the role of science in building the new India. Science, in its comprehensive application to problems of human existence, is the one agency which, in the transition period through which India is passing, will lift the country out of its abnormal economic and industrial depression and put it on the high road to progress and human welfare. The first requisite is that India should align her scientific organisation with that of the progressive countries of the world, and Mr. Wadia welcomed the multiplying ties of India's leading men of science with representative men of science of Great Britain, the United States, the U.S.S.R. and the rest of Europe, referring in particular to the value of the United Nations Educational, Scientific and Cultural Organisation, of the international scientific liaison offices, and to the work of the Royal Society Empire Scientific Conference and of the Commonwealth Scientific Official Conference.

Discussing India's response to the latter Conference, he insisted that the unhealthy distinction between official and unofficial scientific workers must go, and that the universities, private research institutions and societies will more and more be the spearheads of scientific progress. Striking progress has been made in the last few years in irrigation and hydraulic research, and the Government during the last year has sanctioned large-scale operations on several hydro-electric power, irrigation and reservoir projects, giving high priority to three large projects connected with the harnessing of the Damodar, the Mahanadi, and the Kosi Rivers. A committee formed under the Board of Scientific and Industrial Research has drawn up a long-range programme of research in nuclear physics and artificial creation of atomic particles to be carried out at the Tata Institute of Fundamental Research and at the Palit Laboratory, University of Calcutta. In regard to minerals, the Government is taking steps to bring under Federal control those of strategic importance and was convening a Conference to formulate a mineral policy for India and to establish executive machinery for guiding production, conservation and utilization of the mineral products mined.

Winchester City Museums, 1847–1947

JULY 15 of this year marked the centenary of the Winchester City Museum, and the curator, Mr. Frank Cottrill, has appropriately marked the occasion with a short account of its history and growth. Established in 1847 as the Hampshire Museum, this institution set out to save for posterity collections illustrative of local history, antiquities and natural history which might otherwise have been "lost or disregarded, retained in private hands, or have found their way to distant exhibitions". For a time the Hampshire Museum flourished on private donations and subscriptions, but later, as has been the case in so many of the local museums founded during or near the same period, this form of support was not maintained. The nature of the collections, however, and the increased use of the Museum by the public, fully justified the upkeep of the institution. Accordingly, in 1851 it was transferred to the custody of the Winchester Town Council, under the government of which it remains at the present time. A Museum Committee was appointed, and the institution from then on became known as the City Museum. In this way was the safety of the Winchester collections safeguarded. Originally housed in the Hyde Abbey schoolroom, the collections were removed first to part of the old jail in Jewry Street, then to the top floor of the Guildhall, and finally, in 1903, to the present building in the Square. Prior to that, in 1898, the Museum was extended by the opening of the Westgate as a second museum. This was largely due to the interest and beneficence of Alderman W. H. Jacob, a keen local historian. A beautiful old building dating from the thirteenth century, but unfortunately overshadowed by modern constructions entirely out of keeping, Westgate to-day houses, among other things, the City's famous collection of weights and measures ranging in date from the twelfth to the eighteenth centuries. Here, also, is preserved the Winchester moot-horn of about A.D. 1200.

Mr. Cottrill's proposals for the reorganisation of the Collections concern mainly the very overcrowded City Museum, and he rightly stresses the need for the relegation to store of much of this material if the Museum is to illustrate effectively and teach the early history and subsequent development of the town and county. (Storage in this connexion does not mean that collections will become inaccessible to students and others specifically interested in them.) There is an ever-growing tendency for the smaller museums to specialize in the interests of their own particular region, and this, without doubt, is the only way in which the majority of them can become effective units in the community they serve. The curator of the Winchester Museums clearly wishes for development along similar lines, and if his plans are adopted

the Winchester collections, already well known to students at home, should attract to "the capital city of Alfred and Canute" visitors from farther afield. In the reorganised Museum, he also points out the need for a printed guide and the maintenance of a small reference library. These are matters which are often overlooked by an authority responsible for an otherwise good museum service.

Diseases of Flax

In February 1943 the Minister of Agriculture (Eire) set up a Flax Development Board for the purpose of encouraging flax production. Owing to the stimulus of better prices and a guaranteed market for flax under war-time conditions, the area cropped in 1942 had already risen to 18,552 acres compared with only 4,123 acres in 1939. The Board's activities resulted in a further sharp rise in area under flax, the peak being reached in 1945 when just over 32,800 acres were grown. Such intensive cultivation inevitably introduced fresh problems, and diseases and pests became more prevalent and assumed greater significance. At the request of the Board, Dr. R. McKay has prepared a bulletin, "Flax Diseases" (price 5*s.*), which will meet a long-felt want. Though the information contained in this publication does not claim to be new, it has hitherto been so scattered in various scientific and agricultural journals as to be quite inaccessible to the ordinary farmer, flax inspector or mill-owner. The diseases are grouped according to the causative factor, whether it be fungus, parasitic flowering plant or non-parasitic agent, such as weather conditions. Insect pests are also included. The symptoms are clearly described and illustrated in each case and control measures suggested where possible. References are supplied for those who wish for more detailed information, and a useful glossary of scientific terms included.

Pacific Science

The University of Hawaii has long been an active centre for scientific investigations in the Islands, as has the Bishop Museum, Honolulu. This work will now be intensified as the result of the wise co-ordinating policy laid down by the National Research Council of the Pacific Science Conference at its meeting in Washington in June 1946. Partly as a result of this, the University has undertaken to sponsor a new quarterly journal, entitled *Pacific Science*, which is devoted to the furtherance of biological and physical sciences in the Pacific region. Two numbers of this publication, those for January and April, are now to hand and they are excellently printed, illustrated and produced. The personnel of the editorial board covers a wide range of subjects and, interestingly enough, the editor-in-chief is the head of the Department of English.

Each number consists of sixty-eight pages, very similar in size to *Nature*, and is provided with an attractive coloured cover on the inside of which are useful instructions to authors for the preparation of papers. The two numbers include papers on forestry, geology, ornithology, parasitology, mycology, botany, an apparatus for chloride and oxygen determination for pond waters in the field, and the Tsunami, that long-period gravity wave associated with volcanic disturbance, one of which in April 1946 created such havoc in the Islands. No. 1 contains, as a sort of appendix, the interesting recommendations of the National Research Council referred to above, and No. 2 similarly reviews the facilities for research in the Islands provided by more than twenty government or private institutions. The subscription to *Pacific Science* is 3.00 dollars per annum, payable to the Office of Publications, University of Hawaii, Honolulu 10, Hawaii. With the extraordinary wealth of material available not only in the Islands themselves but also in the rest of the Pacific group which will be included in its scope, the journal should have an assured future, and we wish it every success.

Royal Commission for the Exhibition of 1851

The report of the Board of Management, Royal Commission for the Exhibition of 1851, dated December 1946, covers the seven years since July 25, 1939 (from the Commission, 1 Lowther Gardens, London, S.W.7). The award of industrial bursaries was discontinued on the outbreak of war, and in July 1946 only seven of the twenty-nine bursars appointed in 1939 and none of those appointed earlier remained on the books. While the Board has already given 'rehabilitation' grants to a few bursars who wished to complete their industrial training and who have been unable to obtain assistance for this purpose under the regulations of the Ministry of Labour and National Service, the Board has resolved to suspend the scheme for the present and to re-examine the position when industry in Great Britain and its pattern of recruitment have acquired a more definite pattern. The Board has, however, increased to £500 a year the value of the post-graduate scholarship in naval architecture, and new regulations have been prepared which will open the field to candidates from all university institutions in the United Kingdom which have departments of naval architecture or engineering science. The scholarship will be tenable normally for two years, and the conditions have been designed to make it attractive to the trained research worker. Arrangements have also been made for the partial resumption of the activities of the British School at Rome, and discussions on the re-development plan for the South Kensington estate have been renewed. Certain modifications in the plan have become necessary in view of the urgent importance of extending the Fuel Technology Laboratory already on the site to the west of the Royal College of Music, and which the Imperial College of Science and Technology had originally proposed to relinquish.

The Board of Management also endorses the views expressed by the Science Scholarships Committee in a separate report covering the proceedings of the Committee since April 1939. The Committee, reviewing the working of the Science Research Scholarships Scheme between the two Wars, agrees that no major change is needed in the general principle of the overseas scheme, but recommends that the value of the scholarships should be increased to £350 a year with a £50 annual grant for fees, and that a second annual scholarship should be allocated to India. On the other hand, it recommends that the value of the senior studentships should be increased to £500 a year with a possible extra £50 for expenses, but that the number of annual awards should be reduced from five to four. The additional expense of giving effect to these recommendations is estimated at rather more than £3,000 a year. Particulars are included in the report of the appointments made for 1946 in accordance with these recommendations; although normally only ten overseas scholarships are awarded, an additional scholarship has this year been granted to New Zealand in view of the exceptional merits of the two candidates put forward.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Decay of Negative Mesons in Matter

A VERY drastic change in the present conception of the interaction of mesons with atomic nuclei was suggested by Fermi, Teller and Weisskopf[1] as a result of the experiments by Conversi, Pancini and Piccioni[2], who observed the behaviour of positive and of negative cosmic ray mesons coming to rest in iron or graphite. They find that in iron, disintegration electrons are observed only for positive mesons. According to Tomonaga and Araki[3], this is to be expected because negative mesons—in contrast to positive ones—after being slowed down can approach the nucleus and be absorbed by it in view of the strong interaction postulated by Yukawa to explain nuclear forces. In graphite, on the other hand, decay electrons were observed from both positive and negative mesons. Fermi *et al.* concluded that this was in sharp disagreement with expectation, because according to their estimate it takes only about 10^{-13} sec. until a negative meson in a solid reaches its lowest orbit, from which it should be captured by the nucleus in less than 10^{-15} sec. Since the natural decay time is only 10^{-6} sec., they conclude that from negative mesons no decay electrons should be expected, in contrast to the experimental evidence in graphite.

To calculate the slowing down of mesons with an energy below 2,000 eV. (that is, with smaller velocity than that of the electrons of the solid) these authors use a Fermi gas of free electrons as a model of the solid. I wish to point out that, for non-conductors in any event, this model does not seem to be adequate, and that a better model might be obtained in this case by using an assembly of electronic oscillators as a model of the solid. That this model leads to results entirely different from the free-electron model follows from the fact that a point charge e moving with constant velocity v transfers energy proportional to v^2 to free electrons, but proportional to $\exp(-a\omega/v)$ to an oscillator (frequency $\omega/2\pi$, closest approach a) if $a\omega \gg v$. In this connexion a result obtained by Pelzer and me[4] may be of interest. A point charge moving with constant velocity v through a dielectric with dielectric constant ε having a proper frequency $\omega/2\pi$ transfers to it energy at a rate

$$\frac{\varepsilon - 1}{\varepsilon}\,\frac{e^2}{a_0}\,\omega\gamma e^{-2\gamma}, \text{ approximately,}$$

if $\gamma = a_0\omega/v \gg 1$. Here a_0 is of the order of the zero-point amplitude of the oscillators of which the dielectric is composed. Taking $e^2/a_0 = 10$ eV., $\omega = 10^{16}$ sec.$^{-1}$, $(\varepsilon - 1)/\varepsilon \simeq 1$, and $\gamma = 15\,(13)$ (= ratio of velocities of electrons and mesons of equal energy) yields a rate of loss of only 10^5 (10^7) eV. per sec.

No doubt this crude method of calculation requires considerable improvement to obtain quantitative results. It serves, however, to show (i) that the model of oscillators leads to times of slowing-down which are larger by many orders of magnitude than those of a free-electron model, and (ii) that the rate of loss of energy is a quantity which (in view of the exponential factor) is very sensitive towards variation of $a\omega/v$ and may lead to slowing-down times just above or below the decay time of mesons. It seems possible that even in metals a modification of the method used by Fermi *et al.* might be necessary, taking account of the screening of the charge of the moving meson.

Therefore it seems that the drastic change suggested by Fermi, Teller and Weisskopf[1] need not be contemplated at present, but that very detailed calculations will be required to make predictions about the slowing-down time of mesons.

I wish to express my thanks to my colleagues of this Laboratory for interesting discussions.

H. FRÖHLICH

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Royal Fort, Bristol.
June 23.

[1] Fermi, Teller and Weisskopf, *Phys. Rev.*, **71**, 314 (1947).
[2] Conversi, Pancini and Piccioni, *Phys. Rev.*, **71**, 209 (1947).
[3] Tomonaga and Araki, *Phys. Rev.*, **58**, 90 (1940).
[4] Fröhlich and Pelzer, E.R.A. Report, to be published.

Definition of Nuclear Quadrupole Moments

THE quadrupole moment of a nucleus is usually defined[1] as "the quantity $(3z^2 - r^2)_{Av}$, where the average is taken over the nuclear charges for the state which has the maximum component of spin I in the z direction". This seems to imply that the average is taken over all the protons in the nucleus; but if this be so, it is impossible to reconcile the measured values of nuclear quadrupole moments quoted by Mattauch[2] with current ideas of nuclear size. Thus the quadrupole moment of tantalum is reported to be 6×10^{-24} cm.^{2}, which seems incompatible with a nuclear radius of about 9×10^{-13} cm. It seemed desirable, therefore, to examine carefully the derivation of the measured values.

All the quadrupole moments so far measured have been determined spectroscopically by analysing the deviation of the hyperfine structure from the interval rule. In all cases the calculation has depended ultimately on the theoretical work of Casimir[3]. Reference to Casimir's essay reveals that he defines the quadrupole moment as $Q = \int\rho(3z^2 - r^2)d\tau$, where ρe is the charge density of a volume element $d\tau$ and the integral is taken over the whole of the nucleus. Casimir calls this an average and writes it $\overline{(3z^2 - r^2)}$; but the use of the term 'average' in this context appears to have caused some confusion, for the following reason. If the quadrupole moment is regarded as due to a single proton, the remaining protons being assumed to have a spherically symmetrical distribution and therefore contributing nothing to the integral, then Q as so defined is the average value of $(3z^2 - r^2)$ for that proton. On the other hand, if each proton in the nucleus is regarded as contributing to the quadrupole moment, then the average value of $(3z^2 - r^2)$ over all protons is Q/Z, where Z is the total number of protons. Thus each of the quantities Q and Q/Z can, with some justification, be called an 'average' of $(3z^2 - r^2)$, depending on the system over which the average is taken. If one bears in mind that the quantities which have been measured experimentally are the values of Q, and not of Q/Z, they are seen to be of the expected order of magnitude.

It should be pointed out that whereas most writers on the subject adopt Casimir's convention in calling Q the 'average', this is not universally so. For example, Feather[4] explicitly defines the quadrupole

moment (which he denotes by q) as the average over all protons, and in support of his definition states that the quadrupole field is proportional to Zq. However, the experimental values which he quotes are values of Q, so that these should be divided by Z to conform to his definition.

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May 30.

[1] See, for example, Kellogg, Rabi, Ramsey and Zacharias, *Phys. Rev.*, **57**, 677 (1940).
[2] Mattauch, "Kernphysikalische Tabellen" (Springer, 1942).
[3] Casimir, "On the Interaction between Atomic Nuclei and Electrons". Prize essay published by Teyler's Tweede Genootschap. Also published in *Archives du Musée Teyler*, iii, **8**, 201 (1936).
[4] Feather, "Nuclear Physics" (Cambridge, 1936), 109.

Probabilities of Magnetization

IN an earlier analysis of the B—H curves of polycrystalline iron it was shown that a simple 'trichotomy' of the steep part of the curves could lead to useful estimates of the quantitative distribution of operative lattice orientation along any given direction in polycrystalline sheet material[1]. Subsequent work was directed towards correlating such estimates with directional measurements of Young's modulus[2]; and it has been found that while the general trend of agreement is unmistakable, there is a consistent tendency for the trichotometrical method, when applied along the rolling direction, to yield a modest over-assessment of the operative percentage of [100] orientation.

The most likely causes of a systematic discrepancy of this kind would appear to be: (1) that there is a deficiency in the previously adopted conventional assumption that in the demagnetized state there will exist an equivolumetric distribution of domain magnetization along each of the six possible [100] crystal directions of easy magnetization; and (2) that the original approximation made no provision for the inevitable overlapping between the 'easy' reversals in one crystal-group and the 'hard' reversals in another.

An attempt has therefore been made to arrive at a sounder physical basis for the concept of trichotomy, and at the same time to gain further insight into the actual build-up of the technical magnetization curve, by postulating that the 180° reversal component of the steep part of the curve (for polycrystalline iron) will represent the summation of three probability-integrals, one for each of the idealized [100], [110] and [111] crystal-groups; and that each of these three integrals will satisfy a relationship of the form

$$\mu_d = \mu_{dm} \cdot \exp\,[-b\,\{1 - (H/H_m)\}^2], \quad . \quad (1)$$

where μ_d is the differential permeability; μ_{dm} is the maximum value of μ_d; and b is a 'variance' factor or a 'distribution index' which will reflect, for any given crystal-group, the manner in which the achievement of 180° reversals is distributed about some characteristic 'mode' H_m of the critical field strength.

This revised treatment will clearly lead to a general relationship of the form

$$B = \mu_n H + \Sigma\mu_{dm} \int_0^{H<2H_m} \exp\,[-b\,\{1 - (H/H_m)\}^2]\,dH, \quad (2)$$

where B is the externally measured magnetic induction, and μ_n is of the same order as the initial permeability μ_0. For iron and iron-silicon alloys, the summation term will comprise the areas generated by equation (1) for each of the three idealized crystal-groups. In equation (2), the $\mu_n H$ term will ordinarily be relatively small.

Investigation along these lines has indicated that this method of synthesis can lead to consistently improved and close agreement with observation up to the 'knee' region of the magnetization curve, that is, up to the point at which 180°-reversals are expected to be substantially completed[1]. A detailed discussion of its apparent applicability to a variety of experimentally induced conditions is in course of preparation for later publication, and the present communication is being submitted because the general picture which presents itself seems to provide an explanatory background for the peculiarly 'peaked' K_d curves recently recorded on certain types of ferromagnetic wire[3]. It will readily be seen that the summation term of equation (2) is fully competent to take charge of sharply segregated inhomogeneities of magnetization such as would result from the existence of markedly differing 'phases' in a ferromagnetic specimen; each phase will be expected to behave in accordance with its own 'probabilities', with resultant irregularities in the observed K_d curve. It is also clear that the physical basis of the treatment is in complete harmony with the expressed view that the irregularities observed "represent 180° reversals of demagnetized domain orientation of magnetization at values of H corresponding to the critical value of H_c for different ferritic combinations."[3]

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May 24.

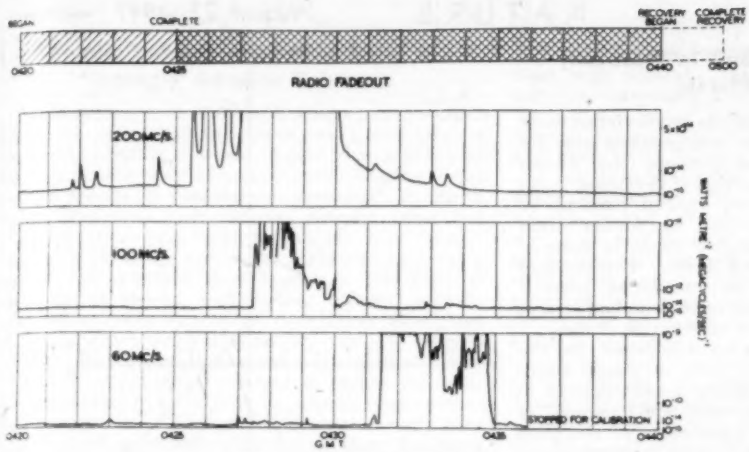
[1] Richer, *J. Iron and Steel Inst.*, **150**, 111 (1944).
[2] Richer, *Metallurgia*, **33**, 251 (1946).
[3] Hobson, *Nature*, **159**, 436 (1947).

Relative Times of Arrival of Bursts of Solar Noise on Different Radio Frequencies

IT is becoming recognized that on metre wavelengths solar noise from the disturbed sun is characterized by the occurrence of sudden large increases in intensity of a duration of several seconds or minutes. Bowen[1], of this Laboratory, has reported that these increases of intensity are not necessarily coincident in time or shape when observed on different radio frequencies. The present communication describes observations, chiefly during July and August 1946, of the relative times of arrival of such bursts on 200, 75 and 60 Mc./s., with a few observations on 30 Mc./s. For each frequency a separate receiving system, actuating its own recording meter, was used. Loud-speakers were also connected giving aural confirmation of the recorded data.

Three main conclusions can be drawn from these observations:

1. *Lack of correlation between most bursts.* First and most important, the majority of the intensity variations, particularly the smaller ones, show no correlation with those on other frequencies. This supports a hypothesis that the noise on different



LARGE OUTBURST OF MARCH 8, 1947

frequencies normally originates in widely separated levels in the sun's atmosphere, and that the disturbances do not generally extend over a wide range of heights.

2. *Correlation between many of the larger bursts.* Many of the larger bursts are similar in shape and nearly coincident in time. Bursts which are obviously associated in this way occur occasionally on all three frequencies, more often on the two closer ones. Presumably in these cases the disturbances extend through the requisite range of heights, either because the levels are closer or the disturbances of greater extent.

The majority of such associated bursts occur not simultaneously but in the sequence 200, 75, 60 Mc./s. The observed times of delay show considerable scatter; but, of sixty cases of such associated bursts on 75 and 60 Mc./s., the most common delay is 2 sec. That between 200 and 75 Mc./s. is of the same order, but the value is doubtful, owing to the few cases in which identification of corresponding bursts is possible. In the limited observations on 30 Mc./s., some bursts were observed which occurred a few seconds after similar bursts on 60 Mc./s. This time delay in the occurrence of bursts on different frequencies may be due to selective group retardation of the radiation in its passage through the ionized solar atmosphere, or to the excitation of radiation at successive levels by an agency travelling with finite velocity.

3. *Long time delays between some large outbursts.* Longer delays of several minutes duration have been observed occasionally between outbursts of exceptionally high intensity, in the same sequence 200, 75, 60 Mc./s. An outstanding example was the great outburst of noise on March 8, 1947, which was accompanied by a solar flare and a radio fade-out. On this occasion the recording frequencies were 200, 100 and 60 Mc./s. Our own 200 Mc./s. equipment was out of action, but a record was obtained by Mount Stromlo Observatory and is used here with their permission. There was a delay of 2 min. between the onset of the outburst on 200 and 100 Mc./s., and 4 min. between 100 and 60 Mc./s. The accompanying graph shows the time-sequence of events with the time of the radio fade-out. Observers at Mount Stromlo report that when optical observations commenced at 0440 a flare was in progress and already decreasing, and had disappeared by 0450. Incidentally, the noise intensity observed on 60 Mc./s. (off-scale at 10^{-9} watts/metre^2/megacycle band-width) is the greatest of which we have record.

The successive delays between the onset of the outburst on 200, 100 and 60 Mc./s. suggest that the outburst was related to some physical agency passing from high-frequency to lower-frequency levels. If we assume, following ideas suggested by Martyn[2], that the radiation at any frequency originates near the level where the coronal density reduces the refractive index to zero, we can derive a rough estimate of these heights from electron-density data given by Baumbach[3]. As the outburst showed no circular polarization on either 60 or 100 Mc./s., the ordinary ray has been considered. The electron densities and heights corresponding to the three frequencies are shown in the accompanying table, together with the velocity of the presumed disturbing agency.

Frequency (Mc./s.)	Electron density per c.c.	Height above base of corona (H) in km.	Delay of onset of outburst ($\triangle T$)	Velocity $\left(\frac{\triangle H}{\triangle T}\right)$
200	5×10^8	0	2 min.	750 km./sec.
100	$1{\cdot}2 \times 10^8$	9×10^4		
60	$0{\cdot}4 \times 10^8$	20×10^4	4 min.	500 km./sec.

It is noteworthy that the derived velocities are of the same order as those of prominence material (some hundreds of kilometres per second) and of auroral particles (1,600 km. per second). An aurora was in fact observed in some parts of Australia on the evening of March 9, a little more than a day after the outburst.

This work is part of the research programme of the Council for Scientific and Industrial Research. We are indebted to the Commonwealth Astronomer for information on the solar flare and the 200 Mc./s. noise during the great outburst of March 8, and to the Overseas Telecommunications Commission (Australia) for information on the radio fade-out on the same date. Of our own colleagues we should particularly like to thank Dr. J. L. Pawsey for his interest and helpful discussions throughout all phases of the work.

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[1] As reported by Reber, G., and Greenstein, J. L., *Observatory*, **67**, 15 (1947).
[2] Martyn, D. F., *Nature*, **159**, 26 (1947).
[3] Baumbach, *Ast. Nach.*, **263**, 121 (1937).

Residual Lattice Strains in Plastically Deformed Metals

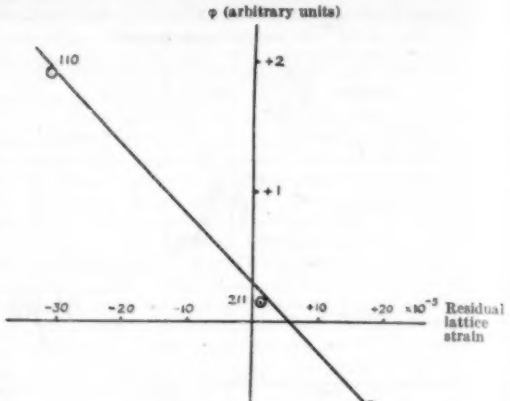
By measuring the change of the atomic interplanar spacing during a tensile (or compressive) test by means of X-ray diffraction methods, the 'lattice strain' can be plotted as a function of the stress. Such stress-*v.*-lattice strain curves, studied particularly by Smith and Wood[1], show that the lattice strain does not vanish when the applied stress is removed from the plastically deformed metal. This residual lattice strain must be due to microscopic residual stresses[2], and an investigation of the residual strains helps to clarify the origin and distribution of these.

In the present communication it is shown that the internal stresses arise mainly from the plastic anisotropy of the metal. The tensile stress required to cause glide in a given grain—the 'yield tension' of the grain—depends on the orientation of the glide planes and glide directions. In a polycrystalline aggregate deforming plastically under a tensile stress, grains with a high-yield tension will carry a greater stress than their neighbours, the orientations of which are such that they glide more easily. On removing the applied load a complicated stress system will arise in the aggregate; grains of high-yield tension will, in general, remain in tension, and those of low-yield tension will be in compression. The X-ray diffraction technique picks out grains of certain orientations, the normals to the reflecting planes being in a direction fixed geometrically by the X-ray beams. The 'residual lattice strain' found from a given X-ray reflexion is not the mean of the strains of all the grains, which is zero, but a mean of the strains of grains with particular orientations. This in general will not be zero; it must be expected to vary with the particular reflecting plane examined, and both positive and negative values should be found, depending on the choice of reflecting plane. On the other hand, an explanation of the residual lattice strain of the type proposed by Smith and Wood[1] would seem to demand that all reflexions should show approximately the same value.

Experimental work carried out to test the validity of the hypothesis outlined was as follows. Annealed metal wires of about 0·5 mm. diameter and extended plastically to the breaking point were photographed in a 19-cm. Bradley–Jay X-ray diffraction camera. Several characteristic X-radiations were used to obtain reflexions at high θ values for as many planes as possible. The strains for each reflecting plane were obtained by comparing the lattice spacings obtained from these photographs with those obtained from photographs taken of the same pieces of wire after re-annealing. The strains were always measured in a direction normal to that of the applied stress. In the results a residual lattice strain of sign opposite to the strain produced by the originally applied stress is denoted positive. Using this convention, the residual strains shown in the curves of Smith and Wood are always positive.

RESIDUAL LATTICE STRAINS FOR VARIOUS REFLECTING PLANES AFTER PLASTIC EXTENSION

Metal	Plane reflecting	Residual lattice strain
Iron	310	$+18\times10^{-5}$
	211	+1
	110	−31
Magnesium	$10\bar{1}5$	−3
	$12\bar{3}3$	+3
	$11\bar{2}4$	+2
	$20\bar{2}3$	0
	$10\bar{1}4$	−7
	$20\bar{2}5$	−3
	$12\bar{3}1$	+4
	0006	−5
	$30\bar{3}2$	+2
	$20\bar{2}4$	+3
	$30\bar{3}0$	+4



The table shows the results obtained for iron and for magnesium, the probable error of the residual lattice strains being about 1×10^{-5}.

For iron, a rough estimate of the average yield tension for grains of various orientations can be made from calculations performed for single crystals. If φ denotes the excess of the average yield tension for those grains contributing to a given reflexion over the mean value for all the grains in the aggregate, then it can be shown that a plot of the residual lattice strain against φ for various reflecting planes should be a straight line through the origin with a negative gradient. This graph is shown in the figure.

Similar results have been obtained with copper and aluminium, and it is considered that they afford confirmation of the hypothesis put forward.

The calculations of the yield tension indicate that this quantity varies rapidly with the angle between the applied stress and the reflecting normal. This angle is 90° in the experimental method used here, and about 80° for the usual back-reflexion camera technique; it is impossible to compare results obtained by the two methods. Further work is being undertaken to investigate the possible effect of specimen size and shape on the residual lattice strain.

This work has been carried out for the Royal Aircraft Establishment as part of a programme for the development of the X-ray method of measuring locked-up stresses in fabricated metal parts.

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May 12.

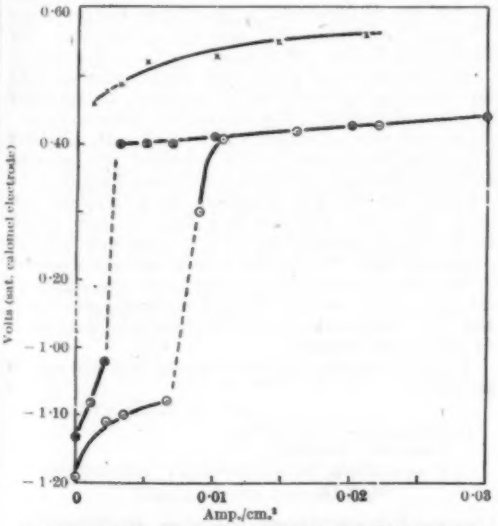
[1] Smith and Wood, *Proc. Roy. Soc.*, A, **182**, 404 (1944).
[2] Heyn, Festband K. W. Gesellschaft, 131 (1921). Masing, *Wiss. Siemens Konzern*, **5**, 135, 142 (1926).

Anodic Behaviour of Mild Steel in Strongly Alkaline Solutions

In connexion with the well-known intercrystalline failure of mild steel in concentrated solutions of sodium hydroxide, it would appear that a study of the anodic behaviour of iron in such solutions might lead to results of considerable interest. A search of the literature soon reveals, however, that but little attention has been devoted to this matter. The work of Grube and Gmelin[1], who carried out a careful and extensive investigation in this field, is therefore of special importance. These workers obtained evidence that anodic dissolution takes place in two distinct potential stages: at low current densities electrolysis proceeds at a potential of about − 0·85 V. (hydrogen), whereas at higher values it changes suddenly to + 0·65 V., when oxygen evolution commences. The critical current density was found to increase rapidly with temperature. Evidence is adduced by Grube and Gmelin that the lower (more negative) potential stage is associated with the formation of ferrous ion, and the higher with oxidation to the hexavalent ion Fe^{6+}; anionic complexes being formed having the probable compositions $(FeO_2)''$ and $(FeO_4)''$ respectively.

I have carried out a few exploratory experiments on similar lines, with special reference to the influence of the molality of the solution. I used unstirred solutions, with a vertical electrode, though the degree of agitation and the position of the electrode appear to have little influence in this case. Some results are represented in the accompanying figure. These refer to a dead soft mild steel (0·05 per cent carbon) and were obtained at 80° C. The curves of potential against the saturated calomel electrode are plotted to a base of apparent current density.

A certain amount of instability of the lower potential stage was observed near the critical current density, especially at the lower molalities. Further work indicated that this effect was attributable to the influence of time, in that the electrode tended to become passive at a current density considerably below the supposed critical value, provided sufficient time were allowed; for example, in a 12·9 molar solution, in which the apparent critical current density was about 0·003 amp./cm.², the electrode became passive after 40 minutes at 0·001 amp./cm.², and after 10–12 minutes at 0·002 amp./cm.².



ANODIC ELECTROLYSIS OF MILD STEEL IN AQUEOUS SODIUM HYDROXIDE: ×, 1·5 *M*; ⊕, 6·2 *M*; ○, 12·9 *M*

A simple and plausible explanation of the existence and quasi-stability of the lower potential stage seems possible on the following lines. As is customary in such work, and like Grube and Gmelin, I subjected the anode to a previous cathodic polarization in order to remove the air-formed oxide film on the metal. Now experiments in a somewhat different connexion have shown that hydrogen is occluded by iron when the latter is cathodized in strongly alkaline solutions in quantities which increase rapidly with the strength of the solution. It seems probable, therefore, that during the initial stages of anodic polarization this occluded hydrogen will effectively prevent the formation of an adherent oxide film and consequent onset of passivity[2].

It is hoped to supplement these initial results and to publish a fuller account of this work later.

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May 22.

[1] Grube and Gmelin, *Z. Elektrochem.*, **26**, 459 (1920).
[2] Cf. Carius, "Korrosion metallischer Werkstoffe" (ed. Bauer-Kröhnke-Masing, Leipzig, 1936), **1**, 135.

X-Ray Diffraction Studies of Yielding in Mild Steel

SIMILAR results to those described by J. M. Cowley and M. S. Paterson in their communication in *Nature*[1] concerning the examination of 'Hartmann's lines' (also known as 'Lüders' lines') in steel using X-ray diffraction methods were reported by me in 1927 [2], and again in 1937 [3] in consequence of a fuller investigation of steel and 'duralumin'. That was the first time the result of X-ray diffraction studies of 'Hartmann's lines' was published, so far as I am aware. Researches on the subject of 'Hartmann's lines' in steel, including a study of their properties, and of which my first memoir was a part, were carried out in the Department of Metallurgy of the University of Birmingham by Mr. T. Henry Turner, Dr. J. D. Jevons and myself, being under the supervision of the first-named.

A noteworthy disclosure in Messrs. Cowley and Paterson's communication is the presence of a considerable proportion of diffuse spots (indicating distorted crystals) with respect to the metal near a 'Hartmann's line' near the centre of a region of 'Hartmann's lines' but not actually forming any part of a 'Hartmann's line' (see their Fig. 1 and Fig. 2 *d*), whereas almost all the spots are diffuse if the part under examination is all part of a 'Hartmann's line'. Further X-ray diffraction studies of such distortion near 'Hartmann's lines' would be of much interest.

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[1] *Nature*, **159**, 846 (1947).
[2] Fell, E. W., Carnegie Scholarship Memoirs (Iron and Steel Institute), **16**, 126 and Fig. 17, Pl. xiii (1927).
[3] Fell, E. W., Carnegie Scholarship Memoirs (Iron and Steel Institute), **26**, 135 and Figs. 19–30. Pls. xiii–xviii (1937).
[4] Fell, E. W., *J. Iron and Steel Inst.*, **132**, 75 (1935).

Smears of Titanium Metal

A REMARKABLE phenomenon is shown by metallic titanium when rubbed against many hard surfaces. If a piece of the metal with a rounded end, of radius of curvature about 1 mm., is pressed firmly on to a hard surface and drawn across it, the metal is left behind in the form of a silvery smear. Smears are obtained with greater difficulty on some substances than on others, but only one crystalline material has been found on which no smear is produced (see accompanying table). The titanium metal may be removed by treatment with hot concentrated hydrochloric or sulphuric acids for about half an hour, or by treatment with cold commercial hydrofluoric acid for a few seconds. Some surfaces which were originally smooth and shiny are seen to have lost their polish after the titanium has been dissolved away. In this way, for example, it is possible to remove the polished surface of glass by rubbing with titanium and then dissolving the metallic smear in hydrochloric acid. The table gives a summary of the results obtained on a number of crystalline materials and on glass.

On Moh's scale the hardness of titanium is less than 5, since it is scratched by apatite but not by fluorspar. It will be seen that in the first place we have the result that a material of hardness 5 can destroy the surface of a crystal of hardness 8, namely, topaz[1]. Among the oxides the surface smoothness is affected only with difficulty or not at all, whereas all the silicates except beryl are readily attacked.

Chemical reaction brought about by rubbing two materials together is well known, and these effects may be due to some chemical reaction of the titanium with the materials on which it is rubbed. The readiness with which silicates react suggests that the titanium may enter into the lattice.

The practical applications of the smears may be (*a*) to coat materials with a metallic layer, (*b*) to etch glass without hydrofluoric acid, and (*c*) to form high resistances of the order of 10^{11} ohms; lines drawn on glass form such resistances, and although not stable against all changes of atmospheric conditions, they are sufficiently stable to be useful.

This investigation arose from a suggestion of Mr. J. B. Nelson and was made possible by a gift of a piece of titanium from Mr. H. F. Kay; we gratefully acknowledge this help. We are indebted to the Department of Mineralogy and Petrology for access to the mineral specimens on which the tests were made.

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Name	Substance: Chemical formula	Substance: Hardness (Moh's scale)	Smear produced: Readily	Smear produced: Not at all	Polish on surface removed: Completely	Polish on surface removed: Partially	Polish on surface removed: Not at all
Diamond	C	10	×				×
Corundum	Al_2O_3	9	×				×
Hæmatite (specular)	Fe_2O_3	5·5–6·5	×			×	
Hæmatite (kidney ore)				×			×
Magnetite	Fe_3O_4	5·5–6·5	×			×	
Rutile	TiO_2	6	×			×	
Chrysoberyl	$BeO.Al_2O_3$	8·5	×				×
Spinel	$(Mg,Fe)O.Al_2O_3$	8	×				×
Quartz	SiO_2	7	×		×		
Topaz	$(Al,F)_2SiO_4$	8	×		×		
Diopside	$CaMg(SiO_3)_2$	5–6	×		×		
Beryl	$Be_3Al_2Si_6O_{18}$	8	×				×
Albite	$NaAlSi_3O_8$	6	×		×		
Axinite	$HCa_2BAl_2(SiO_4)_4$	7	×		×		
Epidote	$HCa_2(Al,Fe)_3Si_3O_{13}$	6–7	×		×		
Garnet	$Ca_3Al_2(SiO_4)_3$	7	×			×	
Tourmaline		7	×		×		
Glass		5	×		×		

[1] Bowden, F. P., Moore, A. J. W., and Tabor, D., *J. Appl. Physics*, **14**, 80 (1943.)

Furansulphonamides

As a recent issue of *Chemical Abstracts* contains an account of the preparation of the sodium and barium salts of furan-2-sulphonic acid[1], by the direct sulphonation of furan, the following report on the indirect production, from pyromucic acid, of simple sulphonation derivatives of furan may be of interest.

The diamide of pyromucic-5-sulphonic acid was prepared, by the method of Hill and Palmer[2], and converted, with barium hydroxide, to furan-2-carboxylic acid-5-sulphonamide

$$C_4H_3O(CONH_2)SO_2NH_2 \longrightarrow C_4H_3O(COOH)SO_2NH_2.$$

Substituted sulphonamido acids were obtained from the dichloride of pyromucic-5-sulphonic acid, as indicated schematically below.

$$C_4H_3O(COCl)SO_2Cl \xrightarrow{CH_3OH} C_4H_3O(COOCH_3)SO_2Cl \xrightarrow{R_1R_2NH} C_4H_3O(COOCH_3)SO_2NR_1R_2 \xrightarrow{NaOH} C_4H_3O(COONa)SO_2NR_1R_2.$$

The above acids were decarboxylated by the method of Gilman and Wright[3].

$$C_4H_3O(COONa)SO_2NH_2(R_2) \xrightarrow{HgCl_2} C_4H_3O(HgCl)SO_2NH_2(R_2) \xrightarrow{HCl} C_4H_3O.SO_2NH_2(R_2).$$

Furan-2-sulphonamide (m.p. 122–123·5°), furan-2-sulphonyl methyl anilide (m.p. 95–98°) and furan-2-sulphonyl-diethylamine, a liquid, were thus prepared.

Furan-3-sulphonic acid and its derivatives were obtained as follows: Pyromucic acid was brominated to the 5-bromo acid, which was sulphonated and the carboxylic group replaced by bromine, as described by Hill and Palmer[4]. The barium 2-5 : dibromofuran-sulphonate thus obtained was treated with zinc and ammonium hydroxide, which replaced the bromine atoms by hydrogen, giving barium furan-3-sulphonate.

From this salt was prepared the *p*-toluidine salt (m.p. 172–173°), and the free acid, an oily liquid, which was reconverted into the barium salt, and the *p*-toluidine salt. The impure sodium salt was obtained, in the usual way, and converted into the sulphonic chloride, from which furan-3-sulphonamide (m.p. 106–108°) and furan-3-sulphonylmethylanilide (m.p. 95–97°) were prepared.

A detailed account of this investigation will appear shortly.

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May 15.

[1] Terent'er, A. P., and Kazitoyra, L. A., *Chem. Abs.*, **41**, No. 7, 2033 (1947).
[2] *Amer. Chem. J.*, **10**, 378 (1888).
[3] *J. Amer. Chem. Soc.*, **55**, 3311 (1933).
[4] *Amer. Chem. J.*, **10**, 413 (1888).

Identification of Creatine by Partition Chromatography

In a study of creatinine metabolism in the rat, to be published elsewhere, creatinine has been identified qualitatively by means of the technique of partition chromatography on paper strips developed by Consden, Gordon and Martin[1]. The apparatus described by Dent[2] has been used, with the further refinement of accurate temperature control obtained by immersing the outer glass container in a water thermostat at 15 ± 0·05° C. Solutions containing *c.* 20–30 γ of creatinine were pipetted on to the paper strips, and after treatment with an appropriate solvent, for example, collidine for 24 hours, the creatinine bands were located by spraying with alkaline sodium picrate.

Some rat urines examined in this manner showed, in addition to a creatinine band, a further Jaffé positive band corresponding to a substance of lower R_f value than creatinine. The second band has since been shown to arise from the creatine, present in the urine, which had undergone movement in the solvent and which had been dehydrated to creatinine during the drying of the paper strips. By means of acid treatment of the strips it is possible to convert creatine more completely to its anhydride *in situ*, and in this way to determine R_f values for creatine.

Further, this procedure affords a method for determining creatine qualitatively in the presence of creatinine, the method adopted being as follows: the test material is pipetted on to the strip and is treated with the appropriate solvent. The strip is dried at 100° C., sprayed with 0·5 *N* sulphuric acid and again heated at 100° C. for 1 hour. Creatine is located on the strip as creatinine by spraying with alkaline sodium picrate. R_f values determined at 15° C. for creatine and creatinine (solvent collidine) both in pure solutions and in rat urine are given in the accompanying table.

	Pure solution	Rat urine
Creatine	0·19	0·15
Creatinine	0·47	0·57

Each figure represents an average of at least six values, the maximum variation obtained being 9 per cent. The R_f values for creatine are sufficiently far removed from those of creatinine to enable clear-cut separation of these substances, and it is therefore possible to identify creatine qualitatively in the presence of considerable amounts of its anhydride.

Further solvents giving suitable R_f values for these two substances are being tried. Creatine and creatinine in phenol move as fast as the solvent. Creatinine shows no movement in amyl alcohol, but has a low R_f value in *n*-butyl alcohol (creatinine in pure solution: 0·20; creatinine in rat urine: 0·25).

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
[2] Dent, C. E., *Lancet*, ii, 637 (1946).

Enzymatic Hydrolysis of Cellulose by *Coniophora cerebella*

During the course of the investigation of the enzymatic activities of wood-destroying moulds[1], an attempt was made to depict the phase sequence of the degradation of the cellulosic fraction of wood; cellulose itself, in the forms of filter paper and surgical cotton, was utilized. *Coniophora cerebella* was found to degrade both forms of cellulose to oxalic acid. Inasmuch as traces of reducing material were found to be formed, and oxalic acid was also obtained by the action of the fungus on glucose, it appeared that an introductory hydrolysis was a necessary prerequisite for the formation of oxalic acid.

A hydrolytic action being involved, it was found useful to examine the residual cellulosic material to determine whether there was an increase or decrease in reducing power. If one were to assume that a hydrolysis similar to that by acids took place, then there would be an increase in reducing power due to the formation of new reducing groups. On the other hand, a split of semi-acetal bonds, the existence of which was first surmised by Tollens, might take place, with the result that the residual material would show a lower reducing value.

Some experiments by Hiller and Pacsu[2] indicated that an *initial* rapid acid hydrolysis of cellulose causes a split of semi-acetal bonds, permitting a *decrease* in reducing power. Consequently, speculation arose whether an enzymatic degradation of cellulose would follow such a pattern, or whether the mould effects a split of 1,4-glycosidic bonds to give rise to new reducing groups.

Surgical cotton which was degraded by *Coniophora cerebella* over a period of sixty days was examined at certain intervals, employing the analytical technique of Hiller and Pacsu, which requires the use of dilute acidic permanganate solution for the determination of reducing power. An inspection of the values recorded in the accompanying table indicates an *increase* in reducing power of the residual cellulose as the oxalic acid content increases:

Dissimilation of surgical cotton by *Coniophora cerebella*

Incubation period Days	Oxalic acid (mgm.)	Milli-equivalents oxygen used up
0	0	0·0500
13	2·35	0·1201
30	6·30	0·2612
60	6·40	0·2668

Values expressed per 1 gm. samples of surgical cotton.

It would appear that the *enzymatic* degradation of cellulose effects a split of 1,4-glycosidic bonds rather than, or concomitant with, a split of semi-acetal linkages.

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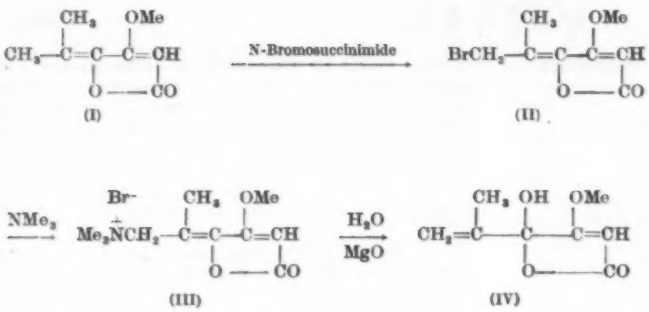
May 31.

[1] Nord and Vitucci, *Nature*, **160**, 224 (1947).
[2] Hiller and Pacsu, *Text. Research J.*, **16**, 490 (1946).

Synthesis of the Antibiotic, Penicillic Acid

Penicillic acid, first isolated by Alsberg and Black[1] from *Penicillium puberulum* Bainier and later by Birkinshaw, Oxford and Raistrick[2] from *Penicillium cyclopium* Westling, was shown to possess the structure (IV) by the latter authors. Later it was observed that the compound was a powerful antibacterial agent, and Oxford[3] has determined that it is much more active than penicillin against Gram-negative organisms.

Penicillic acid has now been synthesized from the lactone (I)[4] as follows:



Treatment of (I) with N-bromosuccinimide gives the bromolactone (II) which, on warming with aqueous trimethylamine, yields the quaternary bromide (III). On boiling an aqueous solution of (III) with excess magnesium oxide, trimethylamine is evolved and penicillic acid (IV) is produced directly. The yields in all the above stages are substantially quantitative.

The mechanism of the last step is formulated thus. The quaternary bromide is first converted to the quaternary hydroxide, which then undergoes the rearrangement already encountered in this field[4]. This has the net effect of adding the elements of water across the double bond. Finally, occurrence of the familiar Hofmann reaction leads to penicillic acid.

The melting point of the synthetic acid is 86–87°, undepressed on admixture with the mould metabolic product; the acetyl and dibromo-compounds likewise give no depression in melting point when mixed with the corresponding derivatives prepared from the natural product. The natural and synthetic acids exhibit identical light absorption properties in the ultra-violet.

The last stages of the above synthesis were carried out during the tenure of an Imperial Chemical Industries Fellowship awarded by the University of London.

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Research Laboratories, May and Baker, Ltd., Dagenham. and Department of Organic Chemistry, Imperial College, London, S.W.7.
June 3.

[1] U.S. Dept. Agric. Bureau Plant Ind. Bull., Nos. 119, 270.
[2] *Biochem. J.*, **30**, 394 (1936).
[3] *Chem. and Ind.*, **61**, 48 (1942).
[4] Raphael, *J. Chem. Soc.*, in the press.

Interpretation of the Exchange of Radio-Sodium in Isolated Muscle

Krogh, in his Croonian Lecture[1] before the Royal Society, considered the apparent impermeability of striated muscle to sodium to be due to an active extrusion of sodium ions. Discussing this view, Conway[2] calculated the minimal energy required for extrusion of sodium from the normal frog's sartorius if sodium entered as fast as potassium. The result was that more than the energy available from the metabolism of the resting muscle would be needed.

In our experiments, isolated frog sartorii were equilibrated with radio-sodium, and the washing out of the isotope was followed. We found that the exchange of the sodium of the muscle fibres with that of the outside medium occurs very rapidly. After correcting for interspatial sodium, it turned out that half the sodium of the fibres was renewed in about half an hour. The use of Ringer solution with high potassium content (12·5–30 mmol.) gave similar results. When the sodium content of the muscle fibres is known, it is possible to calculate the absolute amount of sodium entering and leaving the muscle fibres per unit time; and in the experiments with high potassium these two values differ but slightly. Using Conway's formula (*l.c.*) the rate of passage of sodium corresponds to more than 150 cal. per kgm. per hour at the actual ion concentrations of the experiments, if the exchange of sodium were a true measure of the sodium transported out.

There are, however, certain mechanisms which will allow an exchange of sodium ions between two phases at different concentrations without consumption of chemical energy. In the first place, an exchange without change in concentration may, of course, take place if the difference in concentration is maintained by an electric potential difference; for example, in the case of a Donnan equilibrium. But this cannot be the explanation in the case of the muscle, where the sodium moves out against the potential gradient, the interior of the cells being negative relative to the surrounding medium. In search for a reasonable explanation we may, for example, imagine the cell membrane as an oil layer with suspended particles of some 'Permutite' with an especially high adsorption affinity for sodium. The inside medium may contain radio-sodium at a low concentration, and the outside may contain ordinary sodium at a high concentration. We suppose that the Brownian movements bring one of the 'Permutite' particles into contact with the inside medium. Inactive sodium will then be exchanged with active; later, the particle may come in contact with the outside medium, and the active ions may be given off to this medium in exchange for ordinary ions. In this way, the statistical approach to an equal proportion between active and ordinary sodium ions on both sides of a membrane may proceed at a much higher rate than the approach to equal concentrations on both sides. This is only one of several possible mechanisms which will give the same result; as will also, for example, Lundegårdh's concept[3] of the cell membrane containing acid and basic groups which bind ions of the opposite charge and which sometimes turn round so that they are alternately in contact with both surfaces.

The muscle where the sodium passes out against a concentration gradient as well as against the electrical potential represents a case in which a mechanism similar to that outlined above seems the most reasonable explanation of the experimental facts. However, it must be pointed out that, generally, tracers cannot be used to measure the active transport of ions across a membrane without paying due regard to the fact that part of the apparent transport may be simple exchange.

A detailed account of the tracer experiments performed at this Laboratory will be published in the near future.

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[1] Krogh, A., *Proc. Roy. Soc.*, B, **133**, 140 (1946).
[2] Conway, E. J., *Nature*, **157**, 715 (1946).
[3] Lundegårdh, H., *Arkiv f. Botanik, Stockholm*, **32**, 12 (1945).

'Aerosporin', an Antibiotic Produced by *Bacillus aerosporus* Greer

A BACTERIUM isolated from the soil of a market garden in Surrey during February 1946 and afterwards from a Yorkshire soil and from the air has been found to produce an antibiotic of possible therapeutic importance for which, as it appears to be hitherto undescribed, the name 'Aerosporin'* is proposed. The production and properties of aerosporin are under investigation by a group of workers at the Wellcome Physiological Research Laboratories, and the purpose of the present communication is to direct attention to certain aspects of these studies, the results of which will be published in detail elsewhere.

The organism, a Gram-positive, spore-forming rod, has been identified by Mr. H. Proom with that described by Greer[1] from Chicago tap water as *Bacillus aerosporus*. *B. aerosporus* is considered by some authorities to be synonymous with *B. polymyxa* (Prazm.) Migula, and of three cultures so designated from the National Collection of Type Cultures, two (N.C.T.C. 4747, which originated from the Chicago Board of Health as *B. aerosporus*, and 1380) proved to possess similar antibiotic-producing activity, while one (N.C.T.C. 4745, from the United States and originally designated *B. asterosporus* (Meyer) Migula) did not.

The organism grows well in nutrient broth, but more satisfactory yields of antibiotic are obtained from half-strength broth to which sucrose or glucose and a trace of manganese has been added. In shallow layers at 28° C., the organism grows at the bottom of the culture fluid, where more or less mucilage is formed, depending on the choice of strain and medium. The antibiotic titre increases for four to seven days and then declines.

Aerosporin is a base, and methods for its extraction are similar to methods for streptomycin. Because the activity of the culture fluid is reduced by passage through a candle or a Seitz filter, the bacterial cells are removed by centrifugation. A convenient extraction procedure is one developed by Dr. C. G. Pope from the method for extracting streptomycin described by Van der Brook *et al.*[2] by which the aerosporin is adsorbed on to a suitable activated charcoal, the charcoal treated with dilute sulphuric acid, and the antibiotic eluted with aqueous acetone. The crude aerosporin sulphate is precipitated by the addition of dry acetone.

As described below, aerosporin is active against Gram-negative organisms, and the routine method for its assay has been a dilution method using *Escherichia coli* as the test organism. Two variants of the test have been used. In one the tests are read after approximately three hours incubation at 37° C.; in the other, after incubation overnight at 28° C.

Aerosporin is selective in its action against Gram-negative organisms. Among the more interesting of the pathogens against which it has proved chemotherapeutic in experimental infections in animals are *Hæmophillus pertussis*, *Eberthella typhosa* and *Escherichia coli* in the field of human medicine, and *Brucella bronchiseptica* and *Escherichia coli* strains of 'calf scour' in the veterinary field. The antibiotic is bactericidal in action, and, where attempted, cultural methods have failed to produce resistant strains.

Aerosporin is readily produced, is relatively stable, and in addition to its selective action is of high intrinsic potency. Weight for weight it has the same order of chemotherapeutic activity against Gram-negative organisms as has penicillin against Gram-positive.

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May 19.

* Application has been made by the Wellcome Foundation, Ltd., for the registration of the word 'Aerosporin' as a trade mark.

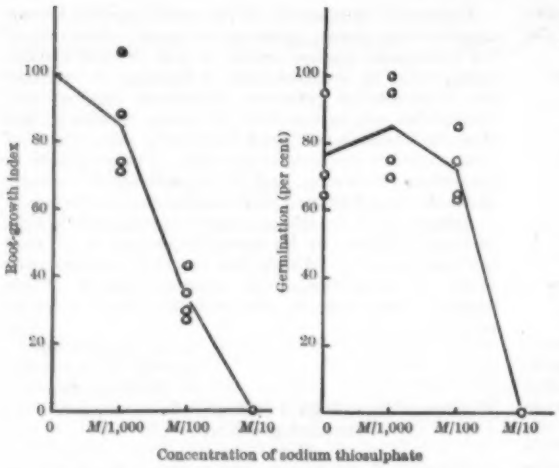
[1] *J. Infect. Dis.*, **42**, 508 (1928).
[2] *J. Biol. Chem.*, **165** (2), 463 (1946).

Selective Toxic Action of Thiosulphate on Plants

INVESTIGATIONS have been recently carried out on the effects of low concentrations of sodium thiosulphate on the germination and subsequent root growth of a number of plants. (These investigations were undertaken as a result of earlier work, not yet published, by Quastel, Hewitt and Nicholas, on the effects of thiosulphate on growth of crops in soils.)

The experiments were carried out with sterile seeds grown under rigidly sterile conditions by a technique recently described[1,2]. Three concentrations (namely, $M/1{,}000$, $M/100$ and $M/10$) of thiosulphate, together with controls, were used in normal culture solutions. Concentrations and controls were usually set up in triplicate, samples of 10–20 seeds being used in each tube or set of tubes. After a period of 7–10 days growth at 20–22° C. in artificial light (9 hours per day) the percentage germination and total weight of roots produced were found for each concentration. From these figures the 'root-growth index' (ratio of average weight of roots per seedling in thiosulphate solution to average weight of roots per control seedling multiplied by 100) has been calculated, and this gives a direct indication of root-growth inhibition by thiosulphate. This provides a rigid separation of the two effects (namely, on root growth and on germination).

Results for experiments on cress (*Lepidium sativum*) are seen in the accompanying figure, where root-growth index and percentage germination are plotted against a logarithmic scale of increasing thiosulphate concentrations. The straight lines join the mid-points of the observed values for each concentration. By interpolation, the concentration of thiosulphate necessary for 50 per cent inhibition of both root growth and germination can be roughly estimated. With cress these concentrations are $4{\cdot}7 \times M/1{,}000$ and $26 \times M/1{,}000$ for root growth and germination respectively.



GRAPHS SHOWING EFFECTS OF VARIOUS CONCENTRATIONS OF SODIUM THIOSULPHATE ON ROOT GROWTH AND PERCENTAGE GERMINATION OF CRESS (*Lepidium sativum*)

Similar calculations have been made from graphs constructed for other species investigated. These results appear in the accompanying table. Here the

Plant	Concentrations producing 50 per cent inhibition	
	Of root growth	Of germination
Garden pea	4·0 × *M*/1,000	31·0 × *M*/1,000
Cress	4·7 ,,	26·0 ,,
Cabbage	6·0 ,,	20·0 ,,
Rape	10·0 ,,	25·0 ,,
Maize	11·0 ,,	31·0 ,,
Flax	20·0 ,,	33·0 ,,
Radish	25·0 ,,	80·0 ,,
Mustard	27·0 ,,	15·0 ,,
Carrot	41·0 ,,	38·0 ,,

plants are arranged in order of decreasing sensitivity, judged on their root growth. It will be seen that there is a considerable range of sensitivity, from garden pea at the sensitive end of the scale to carrot at the insensitive end. On the whole, much higher concentrations are necessary to produce the same degree of inhibition of germination. Thus thiosulphate shows a considerable degree of selectivity in its toxic action on the growth of plant roots.

The effects of two other sulphur compounds, sodium dithionate and potassium trithionate, on cress have been investigated. Neither of these compounds is as toxic as sodium thiosulphate, the concentrations necessary to produce 50 per cent inhibition of root growth being 39 × *M*/1,000 for dithionate and 53 × *M*/1,000 for trithionate (compared with 4·7 × *M*/1,000 for thiosulphate).

It is hoped that experiments now in hand may elucidate the mechanism of these inhibitions.

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[1] Audus and Quastel, *Nature*, **159**, 320 (1947).
[2] Audus and Quastel, *Nature*, in the press.

Symbiosis in *Oliarius*

MAHDIHASSAN[1] has recently criticized my interpretation of symbiosis in the Fulgorid insect *Oliarius cuspidatus* Fieb., described by Šulc[2] in 1924. He states that what I interpreted as a mycetome is in fact the testis, the contents being spermatozoa rather than bacteria.

A glance at Šulc's figure, reproduced by Mahdihassan, should be a sufficient demonstration of the untenability of Mahdihassan's position. The object in question, which Šulc unfortunately called the 'interfollicular organ', has no efferent duct and is not composed of follicles. It is formed of a strange syncytium like that found in the bacterial-containing organs of cicad insects, with a low covering epithelium which sends thin septa into the cavity. This cavity is filled with long slender threads with scattered metachromatic nuclei in which all characteristics of sperm are lacking and which, without question, are bacteria.

Moreover, these so-called 'testes' are found in both sexes; and contrary to what Mahdihassan states, they have not been studied in this particular case alone. A pupil of mine, G. Richter[3], was able to study another species, *Oliarius horisanus*, Mats., from Formosa, and found precisely the same type of complicated symbiotic arrangements in the female. Another pupil of mine, H. J. Müller, in his large "Monographie der Fulgoroiden-Symbiose", based on not less than 173 species, finds the same organs in both sexes of several species of *Oliarius*: *O. panzeri* P. Löw, from Germany, *O. tantalus* Gifford, from Hawaii, *O. villosus* F. and other unidentified species, from Brazil.

It was thus scarcely necessary for Mahdihassan to spend months at Brno, where Šulc made his studies, collecting material of a very rare species, to prove me guilty of so gross an error.

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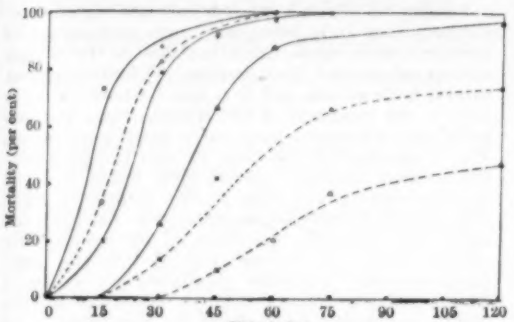
[1] Mahdihassan, S., *Nature*, **159**, 237 (1947).
[2] Šulc, K., *Pub. biol. l'école hautes études vétérinaires, Brno*, **3**, 2 (1924).
[3] Richter, G., *Z. Morph. u. Ökol. der Tier.*, **10** (1928).

Inhibition of the Toxicity of 'Gammexane' for Insects

DURING the course of work on the effect of 'Gammexane' (pure gamma isomer of hexachlorocyclohexane) on the metabolism of fat, protein and carbohydrate by fourth-stage mosquito larvæ, it was observed that the concentration of 'Gammexane' tolerated in the presence of fat (olive oil) was higher than that in the presence of protein or carbohydrate. Further experiments with fourth-stage larvæ of *Aedes ægypti* and *Culex fatigens* confirmed this finding, and it was observed that liquid triglycerides in general provide a degree of protection for larvæ against 'Gammexane'. The findings of Buxton[1] and Upholt[2] indicate that this may be a similar phenomenon to that which results in the inactivation of D.D.T. when applied as a larvicide under natural conditions, suggested by Upholt to be due to adsorption by the organic constituents of mud.

The accompanying graph shows the effect of triolein (mixed in 5 per cent concentration on 0·1 gm. of kaolin) in reducing the mortality of larvæ exposed to



Full lines, 'Gammexane' + kaolin; broken lines, 'Gammexane' + kaolin + triolein

—○— 1·6 p.p.m. 'Gammexane'
—×— 0·8 " "
—△— 0·4 " "

10 ml. of phthalate buffer of *p*H 4·0 (Wigglesworth[3]) containing varying concentrations of 'Gammexane', the control groups being tested in the presence of an equal quantity of kaolin alone. Of substances tested similarly, the following showed no protection: kerosene, refined liquid paraffin, cholesterol, tripalmitin and tristearin. Olive oil, soya bean oil, arachis oil and poppy-seed oil gave partial protection, while tributyrin, triolein, tricaprylin, tricaproin and tri-*n*-valerin showed in that order increasing ability to overcome the toxic effects of 'Gammexane'.

The results of further experiments indicate that this effect cannot be solely explained on the basis of the 'Gammexane' being removed from the aqueous phase by adsorption or solution into the triglyceride, but that the actual ingestion of the triglyceride is necessary. Thus refined liquid paraffin (in which 'Gammexane' is considerably more soluble than in water) does not decrease the toxicity at all (it is itself non-toxic under the conditions of testing). It is improbable that the quantity of 'Gammexane' adsorbed on the solid ingested affects the mortality when compared with the known large quantity of liquid circulated by larvæ[4]. Furthermore, pupæ of *A. ægypti* exposed to 1 p.p.m. of 'Gammexane' solution show no difference in mortality (reaching 100 per cent in 72 hours) whether in the absence or presence of triolein. The relative inefficiency of 'Gammexane' in killing pupæ is comparable to the complete lack of toxicity of D.D.T. towards pupæ[5,6,7]. It is clear that these compounds act more efficiently by ingestion than by contact in the case of mosquito larvæ.

When tested against recently hatched unfed adults of *Cimex lectularius*, the toxicity of 'Gammexane' acting purely as a contact insecticide was also found to be reduced by triolein. The bugs were placed in groups of 10 on filter papers (7 cm. diameter) to which had been applied various mixtures of an acetone solution of 'Gammexane', kerosene and triolein, followed by air-drying for 48 hours before testing. The results, for which no obvious explanation suggests itself, are shown in the accompanying table.

EFFECT OF TRIOLEIN ON TOXICITY OF 'GAMMEXANE' FOR *C. lectularius*

Conc. of 'Gammexane' (mgm./sq. cm.)	Conc. of triolein (ml./sq. cm.)	Conc. of kerosene (ml./sq. cm.)	Observations after exposure of 1½ hr.	4 hr.	20½ hr.
0·05	0·00325	0·00325	Unaffected	Locomotor disturbance	All dead
0·05	0·0065	0	Unaffected	Unaffected	All dead
0·05	0	0·0065	Moribund or paralysed; unable to walk	Moribund or dead	All dead
0·1	0·0026	0·0026	Unaffected	Slight locomotor disturbance	All dead
0·1	0·0052	0	Unaffected	Slight locomotor disturbance	All dead
0·1	0	0·0052	Moribund or paralysed; unable to walk	Moribund or dead	All dead

It is of interest to note that when fed to a rabbit, 'Gammexane' mixed with olive oil does not lose its toxicity for bedbugs afterwards fed on the animal. Further, we have been unable to show that *i*-inositol exerts any inhibitory action against 'Gammexane' in tests with mosquito larvæ. The results of our experiments with mosquito larvæ serve to amplify the observations of Buxton[1] and Upholt[2] concerning the loss of toxicity of D.D.T. when used as a larvicide. If, as suggested by Buxton, D.D.T. dissolves from oil into water in concentration sufficient to be larvicidal, or as Arnold *et al.*[5] conclude, is precipitated out on evaporation of the oil, then the eventual adsorption on the organic constituents of the bottom mud and the intervening ingestion by larvæ of the toxic agent (in aqueous solution or in a state of fine suspension) from subsurface levels would appear to be a factor of some import in the application of larvicides for control of breeding. The greater solubility of 'Gammexane' compared to D.D.T. therefore offers possibilities for more efficient control, particularly of those larvæ which do not rise to the surface (for example, species of the genus *Tæniorhynchus*).

We are indebted to Dr. Walmsley, of African Explosives and Chemical Industries Ltd., for supplies of 'Gammexane', and to Miss U. B. Arvidson for technical assistance.

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April 28.

[1] Buxton, P. A., *Bull. Ent. Res.*, **36**, 165 (1945).
[2] Upholt, W. M., *Pub. Health Rep.*, **62**, 302 (1947).
[3] Wigglesworth, V. B., *J. Exp. Biol.*, **19**, 56 (1942).
[4] Senior-White, R., *Indian J. Med. Res.*, **15**, 969 (1928).
[5] Arnold, E. H., Ferguson, F. F., and Upholt, W. M., *Pub. Health Rep. Supp.*, **186**, 66 (1945).
[6] Upholt, W. M., Gaines, T. B., Simmons, S. W., and Arnold, E. H., *Pub. Health Rep. Supp.*, **186**, 90 (1945).
[7] Ferguson, F. F., Arnold, E. H., and Upholt, W. M., *Pub. Health Rep.*, **62**, 296 (1947).

Urceolarian Epizoites of Flatworms

PERITRICHS (Urceolaridæ) living on the surface of flatworms seem to afford suitable material for a study of the population dynamics of the epizoic habit. The host is widespread, occurs in large numbers, and the smooth surface enables rapid estimation of the numbers of the epizoite. A technique has been developed whereby some twenty flatworms can be dealt with in an hour.

Up to date, two species of Urceolaridæ, *Urceolaria mitra* v. Sieb. and *Trichodina steinii* Clap. et Lach.,

have been recorded from five species of flatworm. There is also a considerable body of descriptive work on these two ciliates; but the ecology seems to have been neglected. The existence of a pond with a large flatworm population in the grounds of the Memorial Buildings, University College, Bangor, has afforded an opportunity of studying the seasonal population changes in *U. mitra*, and some interesting results are emerging. Two species of flatworm abound here, *Polycelis nigra* and *Dugesia lugubris*. Early work suggesting that the epizoite was confined to the former species was confirmed by examining four samples of worms from different parts of the pond. Of fifty-three *P. nigra* taken, all carried the ciliate, whereas the twenty-four *D. lugubris* were negative. Host specificity seemed absolute under natural conditions. No similar record has been found, although Peshkowsky[1] noted that both peritrichs were more abundant on *P. nigra* than on *Dugesia torva* or *D. lugubris*. So far, *T. steinii* has not been found in this pond, although more than five hundred flatworms have been examined.

The preference for *P. nigra* has been tested experimentally by exposing both species of worm simultaneously to *Urceolaria* in watch-glasses. Successful attachments were noted after two days—under experimental conditions *Urceolaria* rarely lived longer, unattached. In ten tests an average of four out of ten (limits, 1–7) *Urceolaria* became attached to *P. nigra*. They did not attach to *D. lugubris*, confirming the field preference. In further experiments *D. lugubris* alone was exposed, and in three out of ten tests attachment occurred, the numbers being 2, 1 and 3. In the last case the peritrichs lived at least eleven days. Thus under certain conditions specificity is not absolute, recalling Fulton's work[2] on the transference of *T. pediculus* from *Hydra* to the gills of Amphibia. Results suggest that the basis of field specificity may be the amount of pigment and its distribution—it does not seem to be ecological.

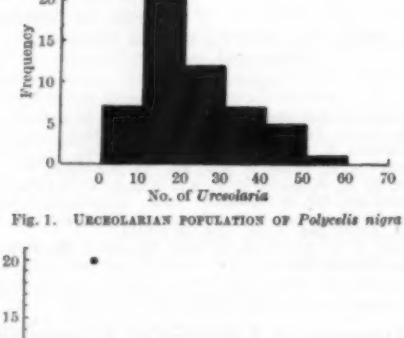

Fig. 1. URCEOLARIAN POPULATION OF *Polycelis nigra*

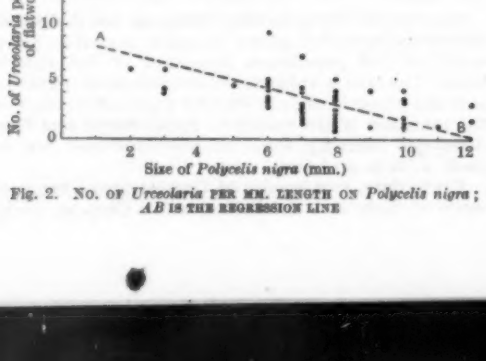

Fig. 2. NO. OF *Urceolaria* PER MM. LENGTH ON *Polycelis nigra*; *AB* IS THE REGRESSION LINE

Paucity of British records of this association[3] suggests that it is infrequent, but examination of flatworms from three other habitats in the Bangor district all yielded Urceolarians. *Polycelis cornuata* carried both species and is a new host record. Not only is the incidence of the epizoite high, but also individual flatworms may carry large populations. Fig. 1 summarizes the data for the College pond; the average number was 22 with limits of 6–55. Arrangement of the data in the form of a trend relating the Urceolarian population to flatworm size shows that the larger specimens do not carry a larger epizoic fauna. It follows (Fig. 2) that the larger flatworms carry a smaller population per unit area. The negative correlation between worm-size and the ciliate population is statistically significant. No explanation of this result, confirmed by later work, is available yet.

It is proposed to study the basis of host specificity, the ecological links between epizoite and host and the factors controlling the size and fluctuations of the peritrich population.

I am indebted to Miss M. Henderson for assistance in the field work and the preparation of this note.

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A Fluorescent Reaction of Tryptophane

IN studying the colour reactions of tryptophane, described by J. Tillmans and A. Alt[1], an intense yellow fluorescence under ultra-violet light was observed.

This reaction has been somewhat improved by me for the purpose of fluorescent analysis. It is carried out by adding to 0·5–2 c.c. of the solution of tryptophane in a test-tube a few drops of a dilute solution of formaldehyde (about 4 per cent); the mixture is then shaken, and concentrated sulphuric acid cautiously poured to the bottom. At the contact of the liquid layers a yellow-brown ring appears, which shows intense yellow fluorescence under ultra-violet light. This fluorescence is readily observable with the naked eye in solutions containing 5 γ per c.c., that is, in a dilution of 1 : 200,000. After shaking, the whole solution shows yellow fluorescence. Solutions containing only the tryptophane fluoresce a bright blue under ultra-violet light.

I have not yet succeeded in isolating the fluorescent colouring matter. It is possibly a 4-carbolin derivative, as a carbolin ring is readily formed by the action of aldehydes upon tryptophane[2,3].

The colouring is permanent. The intensity of fluorescence remains in a stoppered test-tube unchanged for several months.

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ACTIVATION OF COPPER BY OXIDATION AND REDUCTION

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PRELIMINARY X-ray observations on the crystalline changes produced in the metallic and oxide films of copper during the activation process appear to supplement the results of Garner and Stone[1]. The accompanying X-ray diagrams were obtained from narrow slivers of rolled copper sheet 0·0025 in. thick, using copper K_α radiation filtered through nickel foil to remove the β component. A flat quadrant plate spectrometer was used for the comparative X-ray measurements.

In each photograph, quadrants 1 and 3 show the reflexions from the (111) and (020) planes of the bright copper sheet together with faint reflexions from oxide inclusions. These photographs are typical of a metallic structure which is made up of finely divided crystals with preferred axes of orientation due to the rolling process. This specimen was to all intents and purposes inactive as a catalyst.

Quadrants 2 and 4 of Fig. 1 show the X-ray diagram of a sliver of copper strip after oxidation in air at about 850° C. for approximately five minutes. From this X-ray photograph two points are clear: (1) The remaining copper phase has recrystallized into a macro-crystalline form, with destruction of the preferred orientation. (2) The oxide phase is in the form of a finely divided powder which appears to be a mixture of cupric and cuprous oxides.

Quadrants 2 and 4 of Fig. 2 show an X-ray diagram of an oxidized sample of foil after reduction in hydrogen at 250° C. over a period of about one hour and at such a rate that no destruction of the catalytic action of the material was caused by local increases in temperature. The resulting metallic copper can be seen in two forms: one finely divided, from which the reflexions formed a continuous ring on the X-ray diagrams (quadrants 2 and 4, Fig. 2), and the other giving a series of reflexions from individual macroscopic crystals.

During this reduction process, control of temperature is vitally important; in general, it can be said that as the temperature is increased above the optimum of about 250° C., the catalytic action of the resulting copper decreases.

In our opinion, the probable mechanism of activation is as follows.

The outer surface of the copper sheet is oxidized to Cu_2O, which increases the volume occupied by the four copper atoms of the cubic unit cell[2] of the metallic state from $(3{\cdot}608\ \text{A.})^3 = 46{\cdot}93\ \text{A.}^3$ to $(4{\cdot}25\ \text{A.})^3 = 76{\cdot}87\ \text{A.}^3$ in the cubic unit cell comprising two Cu_2O molecules[3], with consequent change in density from 8·93 gm./c.c. to 6·14 gm./c.c. To achieve this, an obvious break-up of the surface of the copper must occur, even though the finely divided crystals of the original sheet are sufficiently mobile to recrystallize into a macro-structure. The further oxidation to cupric oxide also causes an additional slight increase in volume, since the monoclinic cupric oxide unit cell[4] contains four CuO molecules in a volume of $4{\cdot}653 \times 3{\cdot}41 \times 5{\cdot}108 \sin 80°\ 31' = 79{\cdot}94\ \text{A.}^3$; this results in an increased density of 6·569 gm./c.c. This increase in volume on oxidation causes the films of oxide to buckle and crack with the production of small crystals, so that there is always a possibility of oxygen reaching the copper surface.

From a consideration of these results and those of Garner and Stone, we suggest that the following theory might explain, in part, the difference between the reduction of copper by hydrogen and by carbon monoxide at low temperatures, and also account for some, if not all, of the specific effect of hydrogen in producing an activated copper.

The heats of reduction of copper oxide by hydrogen and carbon monoxide are approximately equal, but the thermal conductivity of hydrogen is about seven times that of carbon monoxide. In the case of reduction by hydrogen, the heat generated is rapidly removed from the reaction zone because of the high conductivity of the hydrogen, and the high temperature at these points is not maintained for a sufficient period of time to allow extensive migration of the copper atoms to form large crystals. A porous matrix is therefore produced. Further, as the porosity of the copper is increased during the course of the reaction, the internal surface area increases, thus augmenting the cooling effect and encouraging the formation of a spongy structure.

In the case of reduction by carbon monoxide, only when the copper oxide is in a finely divided state and separated by spacings sufficiently large to facilitate the entry of carbon monoxide into the intercrystalline structure can reduction be carried out at a rate similar to that obtaining with hydrogen. This reduction is most probably accompanied by a recrystallization of the copper into a compact metallic structure, the cooling effect being much less owing to the poorer conductivity of carbon monoxide. This consequent decrease in surface area is responsible for the lower catalytic activity of the resulting

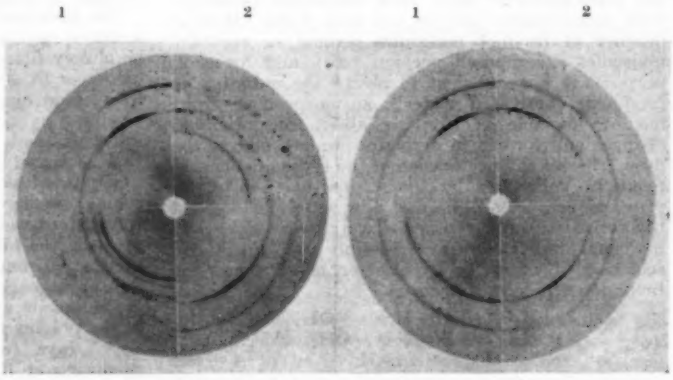

Fig. 1

Fig. 2

Fig. 1. X-RAY PHOTOGRAPHS OF QUADRANTS 1 AND 3 ORIGINAL BRIGHT COPPER SHEET; QUADRANTS 2 AND 4 OXIDIZED COPPER SHEET. COPPER K_α RADIATION, $D = 2$ CM.

Fig. 2. X-RAY PHOTOGRAPH OF QUADRANTS 1 AND 3, ORIGINAL BRIGHT COPPER SHEET; QUADRANTS 2 AND 4, HYDROGEN REDUCED COPPER SHEET AFTER OXIDATION. COPPER K_α RADIATION, $D = 2$ CM.

copper. Following a second oxidation, the reduction with carbon monoxide proceeds with difficulty as the intercrystalline spaces are smaller and the penetration of the carbon monoxide does not occur so readily.

Comparing the crystal size of the activated copper and that of the original rolled sheet, it can be seen that the essential difference between an active and an ordinary copper is not primarily one of crystal size, but of porosity. Thus we suggest that hydrogen reduction under carefully controlled conditions produces an activated copper because the breakdown of oxide crystals occurs without extensive migration of the metallic atoms, and a spongy copper matrix is 'frozen' into position. When carbon monoxide is used, the heat generated is not conducted away from the zone of reaction so rapidly, and recrystallization occurs, with a consequent decrease in the intercrystalline spaces, and the formation of a less porous metal, which becomes increasingly difficult to penetrate with the CO molecule.

We wish to thank the directors of Messrs. Courtaulds, Ltd., for permission to publish this note.

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EFFECT OF GAMMA- AND X-RAYS ON DILUTE AQUEOUS SOLUTIONS OF ACRYLONITRILE

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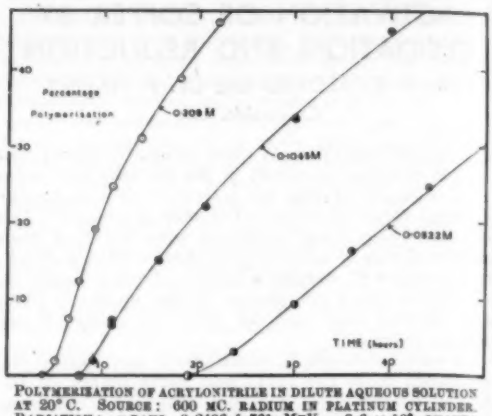
THE immediate effect of the absorption of high-energy radiation (α-, β-, γ- and X-rays, fast protons, deuterons, etc.) by water is the ejection of electrons from the water molecules lying along the tracks of the rays. There has been much discussion concerning the mechanism of the chemical changes which occur in water or dilute aqueous solution as a result of this 'primary radiochemical act'. Many of the investigations[1] have been concerned primarily with measurement of the ion pair yield (M/N is number of product molecules formed or reactant molecules decomposed per ion pair), and for such purposes it was sufficient to regard the radiation as producing 'activated water'[2], an unspecified intermediate capable of bringing about the observed changes and formed in amounts proportional to the dose. Recent reconsideration of the types of chemical reactions undergone by the solutes has led to the view, proposed by Weiss and now widely held[3], that the activated water consists of a hydrogen atom and hydroxyl radical, formed possibly by direct dissociation of water, or by electron capture and ion breakdown processes such as

$$H_2O^+ + e \rightarrow H\cdot + -OH,$$
$$H_2O^+ \rightarrow H_{aq}{}^+ + -OH,$$
$$H_{aq}{}^+ + e \rightarrow H\cdot.$$

In order to test this view, it was decided to investigate whether types of reaction known to be brought about by neutral entities such as H· or —OH, but unaffected by high concentrations of hydrogen or hydroxyl ions, could be induced in dilute aqueous solution by irradiation with X- or γ-rays. To obtain reaction times of reasonable length with the X- and γ-ray sources commonly available, it is necessary to use a reaction for which it is likely that $M/N \gg 1$. It was felt that a polymerization chain-reaction would be particularly suitable. The monomer selected was acrylonitrile, the polymerization of which in aqueous solution can be initiated by hydroxyl radicals generated either by the reaction[4],

$$Fe_{aq}{}^{++} + H_2O_{2aq} \rightarrow Fe_{aq}{}^{+++} + OH_{aq}{}^- + -OH,$$

or by the photolysis by light of wave-lengths greater than 3000 A. of H_2O_{2aq}[5]. Moreover, work on the polymerization sensitized by hydrogen atoms of vinyl compounds in the gas phase[6] suggests that hydrogen atoms in water should also initiate the polymerization of this type of solute. On the other hand, we have found air-free aqueous solutions of acrylonitrile containing high concentrations of hydrogen and hydroxyl ions ($N/2$ sodium hydroxide or sulphuric acid) to be stable for indefinite periods. The experiments outlined below, and of which full details will be published elsewhere, were therefore carried out. The results provide additional evidence for the formation of hydrogen atoms and hydroxyl radicals in water irradiated by X- and γ-rays.



POLYMERIZATION OF ACRYLONITRILE IN DILUTE AQUEOUS SOLUTION AT 20° C. SOURCE: 600 MC. RADIUM IN PLATINUM CYLINDER. RADIATION: γ-RAYS, 0·2406–1·761 MEV. ~ 3·6 × 10^5 QUANTA $CM.^2$ $SEC.^{-1}$ AT 1 CM.

The glass reaction cell, of 20-ml. capacity and with a central cavity into which the radiation source could be closely fitted, was filled with the solution of the monomer in de-aerated water and precautions taken to exclude air. The source (600 mC. radium in a platinum cylinder) was introduced for allotted time intervals, and the extent to which polymerization had occurred was determined by separating the precipitated polymer (either by filtering or centrifuging), washing with methanol and drying at 70° C. to constant weight. Results obtained in this way are given in the table, and some of the percentage polymerization-time curves shown in the accompanying figure. In each run there was an interval before the development of turbidity, which was the first sign of the polymerization. The reaction was also induced by X-rays from an industrial radiography unit operating at 10 mA. and 200 kV., but quantitative measurements have not yet been made.

The data given in the table indicate that, with a γ-ray source, the reaction is of second order with respect to the monomer concentration, and independent of source strength. The ion pair yield (M/N) is at least 10^4 for the 600 mC. source at the highest concentration used, and varies inversely with source

Source strength	Approximate dose-rate*	Monomer concentration	Percentage polym. per hour at steady rate	Second order rate constant × 10^4	Turbidity time
600 mc.	40 r. min.$^{-1}$	0·209 *M.*	4·05	5·4 l.mole^{-1} sec.$^{-1}$	3·7 hr.
,,	,,	0·1045 *M.*	1·95	5·2 ,, ,,	8 ± 0·4 ,,
,,	,,	0·0522 *M.*	1·07	5·7 ,, ,,	19 ± 1 ,,
,,	,,	0·178 *M.*	3·49	5·45 ,, ,,	3·4 ,,
1200 mc.	80 ,,	,,	3·7	5·8 ,, ,,	1·95 ,,

* Calculated as 78 r. min.$^{-1}$ at the surface of the source, a value which agrees with ionization measurements at 3·75 cm. from this source.

strength. These results may be accounted for by assuming that the chemically significant primary act in these experiments is†

$$H_2O \xrightarrow{\gamma} H\cdot + {-}OH, \qquad (1)$$

and that the polymerization chain is initiated by the products of this reaction, that is,

$$H\cdot \text{ or } {-}OH + m_1 \rightarrow m^*_1, \qquad (2)$$

propagated by

$$m^*_j + m_1 \rightarrow m^*_{j+1}, \qquad (3)$$

and terminated by interaction with a hydrogen atom or hydroxyl radical

$$m^*_j + H\cdot \text{ or } {-}OH \rightarrow m_j. \qquad (4)$$

Chain transfer has been disregarded because it would not affect the rate of monomer consumption, and conceivable chain-transfer reactions with water are appreciably endothermic. Chain termination by interaction of growing chains in pairs is eliminated since it leads to a dependence of the rate on source strength and monomer concentration which has not been observed; it would be first order if all the hydrogen atoms and hydroxyl radicals are removed by reaction and none by re-combination, but 1·5th order if reaction 2 is slow compared with recombination of hydrogen and hydroxyl. Confirmation or otherwise of reaction 4 as the chain-ending process would have been possible from measurements of the molecular-weight distributions at different source strengths, since on the above scheme the chain length ($= 2\,k_2\,k_3\,m_1^2/k_4\,R$, where R is the rate of production of radicals in reaction 1) should decrease with increase of source strength. Unfortunately, the samples essential for these determinations did not survive transit, but it is hoped to test this point in the future.

It is of interest that Baxendale, Evans and collaborators[7], in a recent study of the polymerization of methyl methacrylate in aqueous solutions initiated by hydroxyl radicals produced by the Fe^{++}/H_2O_2 reaction, find the predominant mode of chain termination to be in pairs. However, at high initiator concentrations, deviations from their kinetics are found ". . . due to termination by the OH radical . . ." (ref. 7, p. 680). If, as seems likely, a similar effect would be observed in the polymerization of acrylonitrile solutions when the Fe^{++}/H_2O_2 catalyst is used, then it must be presumed that the hydrogen atoms and hydroxyl radicals formed in the solution irradiated by γ-rays are unevenly distributed throughout the system. Such high local concentrations would be expected along the tracks of the fast secondary electrons released by the radiation, and it is of interest that, in the case of X-rays, Lea (*op. cit.*, ref. 3, p. 52) has advanced other evidence for this type of radical localization.

† Following American practice, the symbol $\xrightarrow{h\nu}$ in radiation chemistry will be taken to have a significance parallel to $\longrightarrow$ in photochemistry. See Burton, ref. 3.

The cause of the induction period (that is, turbidity time) is not yet known. Bacon and Evans *et al.*[8] have demonstrated that traces of oxygen lengthen the induction period in reduction activated polymerization of aqueous acrylonitrile solutions; but in our experiments great care was taken to exclude oxygen. The observed dependence of the turbidity time on monomer concentration and source strength (column 6 of the table) can readily be accounted for on the kinetic scheme proposed, provided it is assumed that the (unknown) inhibitor is destroyed by reaction with either or both of the products of reaction 1, as well as by reaction with growing polymer chains.

I am greatly indebted to Dr. N. Miller for frequent discussions and for his help, without which these experiments could not have been brought to the present stage, in the limited time available; to the National Research Council of Canada and the Ministry of Supply for hospitality and facilities; and to Dr. D. E. Lea for discussion.

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[4] Baxendale, Evans and Park, *Trans. Farad. Soc.*, **42**, 155 (1946).
[5] Dainton, to be published.
[6] See, for example, Melville, *Proc. Roy. Soc.*, A, **163**, 511 (1937).
[7] Baxendale, Evans and Kilham, *Trans. Farad. Soc.*, **42**, 668 (1946). Baxendale, Bywater and Evans, *ibid.*, p. 675.
[8] Bacon, *Trans. Farad. Soc.*, **42**, 145 (1946); also ref. 4, p. 163–65.

HYPER- AND AVITAMINOSIS IN MICRO-ORGANISMS

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THE influence of vitamins on micro-organisms is usually estimated according to their accelerating effect upon the growth-rate of micro-organisms. However, cases are known in which some morphogenetic or physiological effects are clearly observed without any visible influence upon the growth-rate. On the other hand, increased growth-rate of the cells cannot always be considered as being due to the presence in the culture of a complete set of the vitamins necessary for normal development. Our morphological and physiological investigations of micro-organisms have shown them to be highly susceptible to changes in vitamin supply.

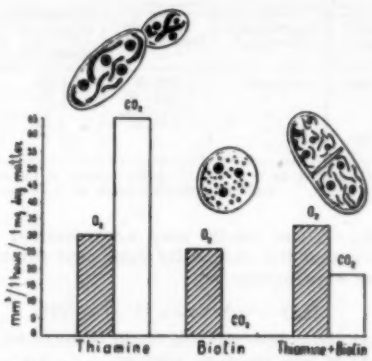
It has been found that the absence of certain vitamins necessary for normal development of the micro-organism may, nevertheless, result in a great increase of the yield. But after some days, because of insufficiency of their protoplast, the cells begin to die and the culture may be completely lost. The data presented below illustrate this point.

The yeast-like fungus *Endomyces magnusii* needs for normal development on Reader's synthetic medium (in which vitamin-free casein hydrolysate is used as a source of nitrogen) chiefly two vitamins

namely, thiamine and biotin. Thiamine may be replaced by 4-methyl-5-oxyethyl-thiazole (vitamin thiazole). Each of these vitamins activated to some extent multiplication of this organism. When applied together, they lead to a great increase of yield[1]. If only thiamine or vitamin thiazole was added to the synthetic medium, the cells of *Endomyces magnusii* accumulate glycogen, volutin and this vitamin also. Cytological observation shows that the nuclei of this organism are enlarged and the chondriosomes are much hypertrophied. Since the features just mentioned are characteristic for the development of this fungus in relatively anaerobic conditions, we have termed this type of cell as the anaerobic or fermentating one[2]. Physiological tests showed that the culture grown in the presence of thiamine possessed the power of fermentation energy five to eight times as large as that in the culture grown in the absence of thiamine. It is of interest to note that the re-organisation in question is taking place in the presence of thiamine even in the aerobic condition, when the fungus is cultivated on the surface of the solid medium[2]. Accumulation of thiamine under these conditions amounts to 120–150 mgm. per gm. of dry material. Such a condition of *Endomyces magnusii* cells may be considered as a thiamine-hypervitaminosis, since the morphological and physiological features of the culture are very different when it is grown on the medium containing the complete set of vitamins. They will be described later, in connexion with a consideration of the combined influence of thiamine and biotin.

If biotin only is added to Reader's synthetic medium, the culture grows for two or three days and then dies off. The cells are spherical. Their protoplasm is heavily vacuolated and completely lacks glycogen and volutine. The chondriosomes are small and dust-like. Such a culture is not capable of fermentation to any noticeable extent and practically lacks thiamine. From the third day onwards, very intensive plasmolysis, coagulation, and necrobiosis of the protoplast take place. The great majority of the cells die off, and then serve as a substrate for single developing cells. There is every reason to interpret this picture as a thiamine-avitaminosis exaggerated by one-sided activation of multiplication, induced under the influence of biotin. Finally, if the medium contains both thiamine and biotin, the whole mass of the culture is extraordinarily increased. All the cells are alive, and elongated in shape. Their protoplasm is well developed, with a large number of fat inclusions. Only small amounts of glycogen and volutin are present. Thin rod-like or thread-like chondriosomes are scattered throughout the cytoplasm. These cultures are characterized by very high consumption of oxygen and weak, although quite measurable, power of fermentation. Such a type almost coincides with the normal culture, grown on the natural solid medium, for example, on the wort-agar medium, and may be designated as a normal aerobic or respiratory one. In the accompanying diagram data are given on the intensity of fermentation and oxygen consumption in cultures grown under conditions of different vitamin supply.

Pathological avitaminous conditions are also readily produced in representatives of the genus *Saccharomyces* when the normal vitamin supply necessary for development breaks down. In this case the depression is especially marked in the absence of pantothenic acid and thiamine.



CYTOLOGICAL APPEARANCE, RATE OF CARBON DIOXIDE PRODUCTION AND OXYGEN UPTAKE BY THE CELLS OF *Endomyces magnusii* GROWN ON SYNTHETIC MEDIA CONTAINING VARIOUS VITAMINS

The conclusion to be drawn from the data presented above is that the vitamin complex necessary for the normal development of micro-organisms is in many cases more than enough for quite intensive growth of the cells. It may well be that intensively growing culture lacking any one factor even of minor importance will show some kind of biological insufficiency. Therefore, there is no reason to regard the intensive growth-rate of the culture as a reliable means for determining the growth factors necessary for normal development of micro-organisms. An incomplete set of the growth factors breaks up their interregulating influence and may lead to extreme one-sided activation of some cell functions; the latter, in turn, gives rise to development of hyper- and avitaminosis.

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CARCINOGENIC ACTIVITY OF PREPARATIONS RICH IN CHOLESTEROL

By Dr. I. HIEGER
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AN earlier report from this Institute[1] recorded that carcinogens had been detected in fractions from human tissues (liver, lung, kidney and muscle) obtained from cancerous and non-cancerous subjects. The activity was concentrated in the cholesterol-rich (*c.* 85 per cent) fraction of the unsaponifiable part of the tissue, and it was suggested (*loc. cit.*, p. 666) that cholesterol itself may not be inert in the carcinogenic process. The further data now available and tabulated below (Table 1) are not incompatible with the hypothesis that cholesterol itself may be carcinogenic, although the alternative view that preparations rich in cholesterol may contain small quantities of an unknown but potent carcinogen cannot yet be excluded; very pure cholesterol prepared chromatographically by Dr. Shoppee is now under test in this Institute.

TABLE 1

C57 strain mice	Initial No. of mice	No. of sarcomas (at site of injection)
Materials tested		
Commercial cholesterol	43	5
9 cholesterol-like compounds (cholesterylene, 7-dehydrocholesterol, etc.)	100	0
Cholesterol-rich fractions from mammalian (cattle) liver	30	0
Commercial cholesterol + certain animal and vegetable oils	60	0
" " + cod liver oil	10	3
" " + unsaponifiable fractions of human liver	20	0
" " + sesame oil	10	1
" " refluxed with KOH and alcohol	20	0
Unsaponifiable fraction of human bile and gall bladders (cholesterol content *c.* 90%)	40	1
" " " cream (cow's milk) (cholesterol content *c.* 90%)	10	1
" " " rat tumour tissue	15	0
Lard alone	10	0
Unsaponifiable fractions of human tissue (cholesterol content 90% and downwards)	227	3
	595	14
Mixed stock mice		
Human liver, unsaponifiable fractions (cholesterol content 90% and downwards)	260	3
Unsaponifiable fraction of gall stones	10	0
M.R.C. strain mice		
Commercial cholesterol	21	2

The technique of testing was described in detail in the paper referred to above; in brief, the essential features were: (1) The material for test were dissolved in lard at 15 per cent concentration (except for the sesame oil experiment). (2) Injection in mice were made subcutaneously in the flank (0·1–0·4 c.c.) at fortnightly intervals; injections were suspended as long as a reservoir of material could be detected by touch. If groups of mice died early in the experiment, they were replaced so as to ensure that a satisfactory number of animals survived long enough in all tests.

The small number of solvent controls (10 mice) need cause no concern, for all the negative results with *C57* mice (namely, 595 − 14 = 581) constitute the controls on the solvent (lard). More than 300 controls on lard have been carried out on mixed stock mice without producing a single sarcoma[1,2]. One must mention, however, that a closely allied species, the rat, behaves differently, for evidence is accumulating that it is liable to sarcoma production by the subcutaneous injection of a variety of fatty substances of animal and vegetable origin.

The latent periods for the different groups of tumours, that is, those produced by commercial cholesterol in lard only and those produced by the other preparations, show much overlap (Table 2).

TABLE 2. LATENT PERIOD OF TUMOURS IN TABLE 1 (MONTHS)

Commercial cholesterol in lard	U.F.* of bile + lard	Commercial cholesterol + sesame oil	Commercial cholesterol + cod liver oil + lard	U.F. of human tissue fractions + lard	U.F. of cream + lard
11	29	14	20	18	13
23			23	19	
13			25	19	
20				16	
22				12	
22				16	
23					

* U.F. = unsaponifiable fraction.

The total production of sarcomas in mice at the site of injection by substances of biological origin is given in Table 3, which represents the chief results of experiments in progress in this Institute up to the time of writing[1,2,3].

TABLE 3

Material	Total sarcomas
1. Unsaponifiable fraction of cow's milk (experiments of Prof. E. L. Kennaway)	1
2. Unsaponifiable fraction of cream (cow's milk)	1
3. Commercial cholesterol	11
4. Unsaponifiable fraction of human tissues (liver, lung, kidney, muscle) and bile from cancerous and non-cancerous subjects	31
Ether extract (that is, saponifiable) of human cancerous liver	2
6 Ether extract (that is, saponifiable) of mouse mammary tissue	1

The foregoing data now suggest three possibilities:

(1) That cholesterol is, in fact, a slow carcinogen, particularly in the presence of other facilitating lipids, and in the absence of inhibiting factors.

(2) That commercial cholesterol (cholesterol content high but uncertain, of the order of 98 per cent perhaps) contains a small amount of an unknown but potent carcinogen; and that cholesterol-rich fractions from human tissues (liver, lung, kidney and muscle), from cow cream, from cattle brain and spinal cord, and from human bile all contain, in addition to cholesterol, the unknown carcinogen.

(3) The operation of unknown factors (for example, important variations of susceptibility of the experimental mice).

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Note added in proof. At the time of writing there are still a few surviving mice in the experiments described in the tables. Thus the total of tumours shown is a minimum figure and may have to be slightly raised when all the mice are dead.

[1] Hieger, I., *Cancer Res.*, **6**, 657 (1946).
[2] Hieger, I., *Amer. J. Cancer*, **39**, 496 (1940).
[3] Hieger, I., *Science*, **93**, 262 (1941).

FORTHCOMING EVENTS

Wednesday, August 27—Wednesday, September 3

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (a Dundee).—109th Annual Meeting.

Wednesday, August 27

In the Caird Hall, City Square, Dundee, at 8.30 p.m.—Sir Henry Dale, O.M., F.R.S.: "Science in War and Peace" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICISTS (2) in the Radiotherapy Service, and an INSTRUMENT MAKER—The Secretary, South Wales and Monmouthshire Joint Cancer Committee, County Hall, Newport, Mon. (August 30).

PRINCIPAL OF THE IPSWICH SCHOOL OF TECHNOLOGY—The Chief Education Officer, 17 Tower Street, Ipswich (August 30).

LECTURER IN PHYSICS, and a LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (August 30).

RESPONSIBLE LECTURER IN PHYSIOLOGY (Senior Assistant)—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (August 30).

UNIVERSITY LECTURER IN MATHEMATICS, with special qualifications in Statistics—The Secretary, Appointments Committee of the Faculty of Mathematics, Trinity College, Cambridge (August 30).

ASSISTANT MASTERS in H.M. Dockyard Schools (one each at Portsmouth and Chatham)—The Director, Education Department, Admiralty, London, S.W.1 (August 30).

LIBRARIAN, and an ASSISTANT LIBRARIAN, at the Coventry Technical College—The Director of Education, Council House, Coventry (August 30).

SENIOR ASSISTANT IN ELECTRICAL ENGINEERING in the Bournemouth Municipal College—The Education Officer, Town Hall, Bournemouth (August 30).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1 (August 30).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Dudley and Staffordshire Technical College, Dudley (August 30).

SENIOR ASSISTANT IN CIVIL ENGINEERING, a SENIOR ASSISTANT IN ELECTRICAL ENGINEERING, a RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 30).

ASSISTANT BACTERIOLOGIST and LECTURER IN BACTERIOLOGY—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (August 31).

VICE-PRINCIPAL AND SENIOR LECTURER IN AGRICULTURE, an ASSISTANT LECTURER IN AGRICULTURE with special knowledge of Farm Machinery, an ASSISTANT LECTURER IN AGRICULTURE with special knowledge of Dairying, and a SENIOR INSTRUCTRESS IN RURAL DOMESTIC ECONOMY—The Principal, Yorkshire Institute of Agriculture, Askham Bryan, York (September 1).

HEAD OF THE NATIONAL FOUNDRY COLLEGE being established to provide for technical education and research in connexion with the Foundry Industry (Ferrous and Non-Ferrous)—The Clerk to the Board of Governors, National Foundry College, at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton (September 6).

EDUCATIONAL PSYCHOLOGIST—The Secretary for Education, County Buildings, Shrewsbury (September 6).

TEACHER OF PHYSICS AND RADIO for day and evening classes—The Secretary, Norwood Technical Institute, Knights Hill, West Norwood, London, S.E.27 (September 6).

LECTURER for advanced teaching and the supervision of research in organic chemistry—Sir Ian Heilbron, F.R.S., Royal College of Science, Imperial College of Science and Technology, South Kensington, London, S.W.7 (September 12).

ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, The University, Manchester 13 (September 13).

LECTURER IN METALLURGY—The Registrar, The University, Leeds 2 (September 15).

LECTURER IN PHYSICS—The Principal, Heriot-Watt College, Edinburgh (September 15).

LECTURER IN PHYSIOLOGY—The Secretary and Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (September 15).

INSPECTOR UNDER THE DANGEROUS DRUGS ACTS—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1958 (September 16).

SENIOR PRINCIPAL SCIENTIFIC OFFICER in the Radio Department of the Royal Aircraft Establishment, Farnborough, Hants, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1962 (September 18).

TUTORIAL STUDENTSHIPS in (*a*) PHYSICS, and (*b*) MECHANICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (September 20).

LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (September 20).

SINGHANEE LECTURER IN FUEL TECHNOLOGY—The Registrar, University of Bombay, Bombay 1, India (September 29).

GEOLOGISTS, and SENIOR GEOLOGISTS, in the Geological Survey of Great Britain—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1983 (September 30).

ASSISTANT CONSERVATORS OF FORESTS (2) for the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Forests' (October 1).

GENETICIST (Senior Research Officer or Principal Research Officer), a SILVICULTURIST (Senior Research Officer or Principal Research Officer), a CHEMIST (Research Officer or Senior Research Officer), and a PLANT PATHOLOGIST (Research Officer or Senior Research Officer), at the new Wattle Research Institute attached to the Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 30).

ARTIST-SECRETARY for Pathological Museum—The Dean's Office, St. Thomas's Hospital Medical School, London, S.E.1.

HEAD OF THE MATHEMATICS DEPARTMENT—The Principal, Huddersfield Technical College, Huddersfield.

FISH EXPERT by the Iraqi Government Ministry of Economic Affairs—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14573.

LECTURER IN PHYSICS at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1.

LECTURER IN BIOLOGY, with special knowledge of Zoology—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15.

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Portsmouth Municipal College, Portsmouth.

SENIOR ASSISTANTS IN THE DEPARTMENTS OF CIVIL AND MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, and PHYSICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, The University, Edinburgh.

DEMONSTRATOR IN THE DEPARTMENT OF PHARMACY—The Secretary, Royal Technical College, Glasgow.

LABORATORY TECHNICIAN (Grade B) IN THE PHYSIOLOGY DEPARTMENT, and a LABORATORY TECHNICIAN (Grade C) IN THE CHEMISTRY DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

GRADUATES IN PHYSICS or CHEMISTRY to conduct research into problems connected with the manufacture of pottery—The Director of Research, British Pottery Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

LABORATORY TECHNICIAN (Grade B) IN THE AREA PATHOLOGICAL LABORATORY—The Medical Officer of Health, Municipal Buildings, Middlesbrough.

LECTURER OR ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University College, Exeter.

GRADUATE IN AGRICULTURE with organising ability and experience both of teaching and practical farming, as Headmaster of the Jamaica School of Agriculture—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

SENIOR ASSISTANT IN THE DEPARTMENT OF MECHANICAL AND AUTOMOBILE ENGINEERING, Doncaster Technical College—The Chief Education Officer, Education Office, Wood Street, Doncaster.

GRADUATE with First- or Second-Class Honours or Higher Degree in Chemistry, and a GRADUATE with special qualifications in Engineering—The Principal, Mining and Technical Institute, Neath.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

Safe Shell-Fish. Pp. 13 + 4 plates. (Conway: Ministry of Agriculture and Fisheries, 1947.) [123

Department of Industry and Commerce: Meteorological Service. Geophysical Publications, Vol. 1: Harmonic Analysis and Synthesis Schedules for Three to One Hundred Equidistant Values of Empiric Functions. By Prof. L. W. Pollak, assisted by C. Heilbron. Pp. xxxiii + 118. (Dublin: Stationery Office, 1947.) 42*s*. [123

Osmania University, Hyderabad. Publications of the Nizamiah Observatory. Astrographic Catalogue 1900·0, Hyderabad Section (Part 3), Dec. +35° to +40°, from Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the direction of T. P. Bhaskaran. Vol. 12: Measures of Rectangular Co-ordinates and Diameters of 60,144 Star-Images on Plates with Centres in Dec. +36°. Pp. xxx + 229. (London: Percy Lund, Humphries and Co., Ltd., 1946.) 15 rupees; 20*s*. net. [133

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 816, Vol. 240: The Determination of the Depths and Extinction Coefficients of Shallow Water by Air Photography using Colour Filters. By J. Grange Moore. Pp. 163–217 + 15 plates. (London: Cambridge University Press, 1947.) 22*s*. [133

South-Eastern Naturalist and Antiquary: being the Fifty-first Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Fifty-first Annual Congress held at Tunbridge Wells, 1946. Pp. xxxvi + 64 + 5 plates. (Guildford: Hon. Sec., H. M. Mountford, 23 Mountside, 1946.) 5*s*. net. [133

British Library of Political and Economic Science. Annual Report, 1945–46. Pp. 25. (London: London School of Economics, 1946.) [133

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Proceedings of the United States National Museum. Vol. 96, No. 3201: New Cerambycid Beetles belonging to the Tribe Distenlini from Central and South America. By W. S. Fisher. Pp. 329–334. Vol. 96, No. 3202: *Machaeroides eothen* Matthew, the Saber-toothed Creodont of the Bridger Eocene. By C. Lewis Gazin. Pp. 335–348 + plates 45–46. Vol. 96, No. 3203: Review of some Chalcidoid Genera related to *Cerocephala* Westwood. By A. B. Gahan. Pp. 349–376 + plates 47–48. Vol. 96, No. 3204: A Revision of the Genera of Mullets, Fishes of the Family Mugilidae, with Descriptions of Three New Genera. By Leonard P. Schultz. Pp. 377–396. (Washington, D.C.: Government Printing Office, 1946.) [103

Bulletin of the Bingham Oceanographic Collection, Peabody Museum of Natural History. Vol. 10, Article 1: The Macrouridae of the Western North Atlantic and Central American Seas. By Albert E. Parr. Pp. 100. 1.50 dollars. Vol. 10, Article 2: An Analysis of the Deceptive Resemblances of Fishes to Plant Parts, with Critical Remarks on Protective Coloration, Mimicry and Adaptation. By Charles M. Breder, Jr. Pp. 50. 75 cents. (New Haven, Conn.: Yale University, 1946.) [103

Smithsonian Miscellaneous Collections. Vol. 106, No. 19: The Lamina Terminalis and Preoptic Recess in Amphibia. By Albert M. Reese. (Publication 3867). Pp. ii + 9 + 4 plates. (Washington, D.C.: Smithsonian Institution, 1947.) [103

West African Cacao Research Institute. Annual Report, April 1944 to March 1945. Pp. 36. (Tafo: West African Cacao Research Institute; London: Crown Agents for the Colonies, 1946.) 2*s*. [103

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Development and Welfare in the West Indies. Bulletin No. 19*s*: Survey of Animal Husbandry, Feeding, Management and Veterinary Services in the West Indies—British Guiana. Report by Prof. Wm. C. Miller. Pp. 44. (Bridgetown: Advocate Co., Ltd., 1946.) 10 cents. [123

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